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THE PARIS-BORDEAUX-PARIS RACE OF AUTOMOBILE CARRIAGES.

IN order to complete the notes published in our preceding numbers upon the Paris-Bordeaux-Paris race of automobile carriages of the 11th of last June, we reproduce herewith the aspect of the nine prize vehicles, as well as a complete diagram of the race.

As well known, only twenty-eight out of the forty-six vehicles that were entered presented themselves at the exposition at the time desired in order to take part in the race, and but twenty-two effectively took part in it. Out of the twenty-two vehicles that started from the control of Versailles, twelve made a regular turn at Bordeaux before the closing of the register, and nine made the complete trip in less than a hundred hours. Out of these nine carriages, eight were actuated by naphtha or gasoline motors and one, that of Mr. Bollée, dating from 1880, by steam. It was an unquestionable and unquestioned triumph of the gasoline motor in a crude test that gave rise to many doubts as to the endurance of the drivers and of the very complex and delicate parts united upon an automobile carriage.

A description of all these carriages would present but a mediocre interest, and the more so in that they do not differ essentially, as may be seen, from those that won the prizes last year at the same season in the race of horseless carriages organized by the Petit Journal. We reproduce all these carriages in the order of their arrival at Paris, and must state the prize that was awarded to each of them by the committee.

It will be remarked that carriage No. 5 (Fig. 1) of Messrs. Panhard and Levassor, which was the first to reach Paris, and far ahead of the others, obtained only the second prize. The reason of this was that the first prize, according to the terms of the race, could be awarded only to a carriage for four or more passengers. Carriage No. 16, which was the fourth to arrive, obtained the first prize, because, taking account of the hours of starting, it took two minutes less than carriage No. 8 to make the trip.

The complete diagram of the race given in Fig. 10 brings clearly into relief the principal incidents and accidents of it, the greater or less regularity of running of the different carriages, the crossing points and their times, etc.

It is seen, for example, that the last carriage that reached Bordeaux made its turn at the very moment at which carriage No. 5 arrived at Paris, having made the great distance of 705 miles in 48 hours 48 minutes. The running of all the prize gasoline carriages was perfectly characteristic.

Their diagram represents an inverted V, the two legs of which are so much the more rectilinear in proportion as the speed was the more uniform, and so much the closer together in proportion as the speed was greater. From this point of view the run of No. 5 was truly irreproachable. The diagram sufficiently shows, without the necessity of dwelling upon it, the carriages of which not so much could be said.

A few technical facts suggest themselves from the results of this race, and it has seemed to us of interest to set them forth upon the score of useful information, in view of the progress that automobile locomotion is destined to make in the near future.

Upon the whole, it was the lightest vehicles that behaved the best on the road, and this fact, now indisputably established, proves the superiority of gasoline and naphtha over any other motive power at present known. This, in fact, is because, all things otherwise equal, it suffices to carry 14 ounces of gasoline to produce one horse power for one hour, while steam requires at least 6·5 pounds of coal and from 40 to 45 pounds of water. As for electric accumulators, it would require more than 220 pounds to obtain the same power during the same time.

For a run of five or six hours a few quarts of gasoline suffice, and the weight of the fuel supply becomes entirely negligible before that of the vehicle, motor and passengers. The same is not the case with steam, the generator of which represents, aside from the supply of water and coal, considerable of a dead weight, while electric accumulators are as yet very inferior from this standpoint, since the apparatus, which is very heavy of itself, expends the most available part of its energy in its own propulsion.

Light vehicles permit of benefiting by other appreciable advantages, such as the use of rubber tires, with which all the prize carriages were provided, and even of pneumatic tires, as in carriage No. 46, of Mr. Michelin, which made the trip of 720 miles without any accident to the wheels, despite the weight of 2,375 pounds that it supported. Ball bearings, which have already been applied to the Peugeot carriages, and with which no steam carriage, we believe, was provided, also contributed to the success of the gasoline vehicles in a certain measure.

As for the bicycles, they are of too recent creation, and the test has been too crude to permit of any conclusion whatever being drawn from their want of success. All the speedy steam carriages met with accidents that seem to indicate that the weight of these vehicles, necessitated by the very use of steam, divests

FIG. 1, No. 5.—Panhard and Levassor's Gasoline Carriage for Two Passengers. Second prize, 12,600 francs.

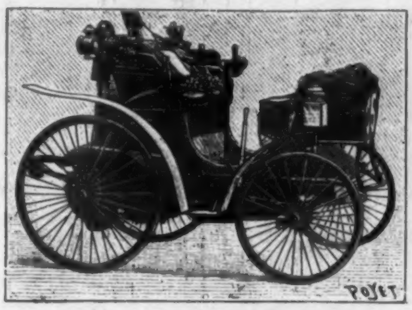


FIG. 2, No. 15.—Peugeot Brothers' Sons' Gasoline Carriage for Two Passengers. Third prize, 6,300 francs.

FIG. 3, No. 8.—Peugeot's Gasoline Carriage for Four Passengers. Fourth prize, 3,150 francs.

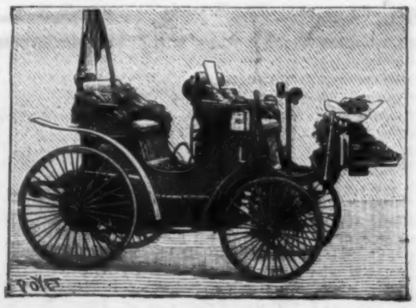


FIG. 4, No. 16.—Peugeot's Four Passenger Phaeton. First prize, 31,500 francs.

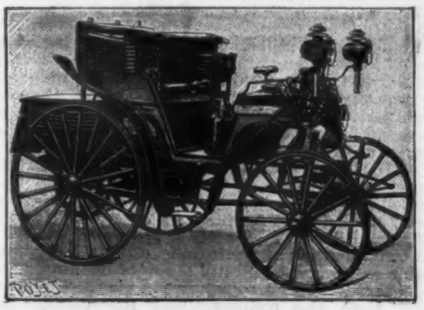


FIG. 5, No. 12.—Roger's Four Passenger Gasoline Carriage Fifth prize, 3,150 francs.

FIG. 6, No. 7.—Panhard and Levassor's Four Passenger Carriage. Sixth prize, 3,150 francs.

FIG. 7, No. 28.—Panhard and Levassor's Five Passenger Carriage. Seventh prize, 3,150 francs.

FIG. 8, No. 13.—Roger's Four Passenger Carriage. Supplementary prize of 1,500 francs.

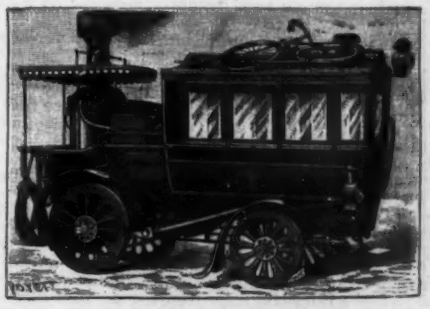


FIG. 9, No. 24.—Bollée's Six Passenger Steam Carriage. Supplementary prize of 1,500 francs.

THE PARIS-BORDEAUX-PARIS RACE OF AUTOMOBILE CARRIAGES.

them of the qualities that we find, on the contrary, in all the gasoline carriages. Carriage No. 24, of Mr. Amedee Bollée (Fig. 9), which is slower and more staid, on account of its respectable age and the purpose for which it was constructed, did not escape accidents; and it was a truly extraordinary thing that the son of Mr. Bollée, the driver of the vehicle, did in repairing in situ, with merely the resources at his disposal upon the carriage, a gearing broken in two pieces, by cutting the cheeks out of a useless piece of iron plate, using old nails for rivets, reforging the broken links on the spot, thus losing 23 hours in a single repair and reaching Paris before the close of the control register.

Accidents, incidents and picturesqueness were not wanting in this race without precedent, and it would require a volume (which some one will probably write one of these days) to perpetuate the remembrance of it. What suggestive reflections are not inspired by the 1895 bicycle lying upon the Bollée carriage of 1880 (Fig. 9); by the bag of ice thrown at the entrance of Etampes into a petroleum carriage for cooling the cylinders; by the bouquets thrown with more enthusiasm than prudence at the unfortunate drivers of the carriages, who were thus bombarded with projectiles having a relative velocity of from 25 to 30 miles an hour; by the walking up of steep gradients in pushing the vehicle ahead; by the carmen who did

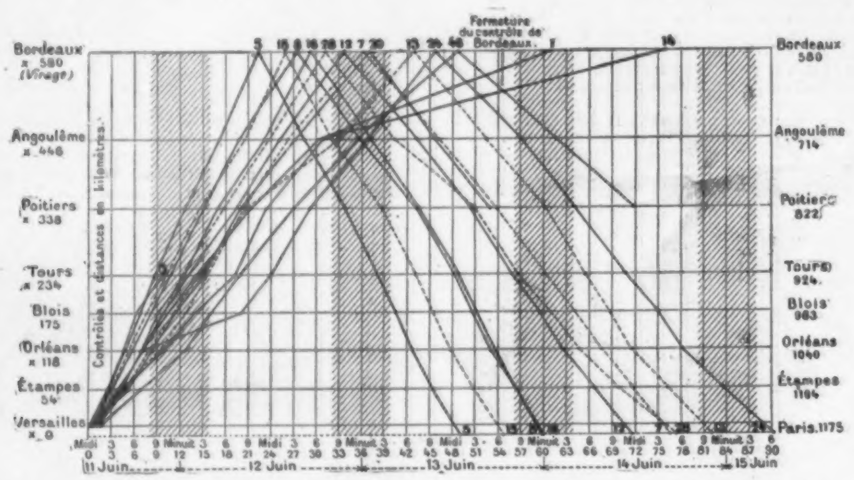


FIG. 10.—Graphic Trace of the Paris-Bordeaux-Paris Race of Automobile Carriages. The times are shown in abscissæ and the distances in ordinates. The figures given beneath the name of each control indicate, in kilometers, the ground passed over from the start at Versailles in going (column to the left) and returning (column to the right). The curves 1 and 3 relate to De Dion's steam carriages, 14 to the Duncan and Suberbie bicycle, and 20 to one of Serpollet's steam carriages. The shaded bands represent nights.

not assert their rights; and by the dogs that crossed the road and upset the carriage in getting crushed!

Despite all such incidents, or rather on account of such incidents, the Paris-Bordeaux-Paris race will remain a memorable event and will mark the date of the advent of a new sport which it seems, however, useless to repeat under conditions so severe and difficult. For our engravings we are indebted to La Nature.

DRAINAGE OF HEATING COILS AND STEAM PIPES.*

THE means principally used for draining steam pipes for all purposes consist (1) of open pipes or those of variable opening, more or less frequently adjusted, for the purpose of allowing, as nearly as possible, all the water of condensation to escape with little or none of the steam, and it is easy to see that all attempts to regulate this by hand are unsuccessful; (2) of the steam trap which opens and closes the outlet automatically, the extent and duration of this opening when trap is working properly depending on the amount of condensation and the size of the outlet; (3) the pump, which is being much used recently, sending its water direct to the boilers; (4) the steam loop, which is of somewhat limited application, and not used for heating coil drainage, completing the list.

Taking up first the subject of steam pipe drainage, which is of very great importance for the safety of the pipe and its economy of steam distribution, we find it the too common practice to place so-called "bleeders," which, while not handling blood, are invested with a rather appropriate name, considering their relation to their owners. These pipes we often find of considerable diameter, and discharging in some out of the way place or ditch, where they bother nobody but the owner of the coal, and this begets a system of nobody bothering them. Often a one inch pipe with "only a half turn" is used, but this, if a valve with a coarse screw, will run the average mill juice pump.

Sometimes a doubtful improvement on this consists in running a larger pipe than before to the feed water reservoir and leaving it "wide open," to make sure of getting rid of the water, "with no waste," as the boiler pumps will catch it all and return it to the boiler, as they do not have a thing to do but to groan under their burden of hot water under pressure; and somehow the (boiling?) water in the heater will manage to condense (?) the large surplus of steam thus blowing out. Of course this is bad practice, and can easily be, and often is, worse than the bleeder blowing to the winds. For in one case a large amount of steam is going absolutely to waste and a small amount of water is recovered, and in the other the same amount of water and but a comparatively small amount of steam are going to waste.

It goes without question that the only correct way to drain steam pipes is first to determine the fall or grade of the pipe to given points, and there locate good separators which will arrest most, if not all, of the entrained and condensed water, from the bottom of which separators the water arrested can be piped to the hot water reservoir with an open pipe. This brings us back to the previously mentioned condition, except that the separator has saved the engines it protects if its drain is sufficiently open, and if too open, of course, is wasting steam. Separators should each be supplemented by a good trap, as it is practically impossible to get good and economical service otherwise. The attendant gets busy and forgets, the trap keeps busy and does not forget.

As to draining steam pipes when steam is first admitted, it is impossible to have the caution given us too often against admitting the steam too suddenly, and to have all available outlets opened slightly. In the absence of bleeders, this can be equally well done through the cylinders of the various engines and pumps. The best practice, when possible, is to raise steam in the pipes; that is, with all branches open from the boiler main and all extremities slightly open. It would seem that an absolutely safe practice for warming up steam pipes would be that they should not be raised to the boiler steam temperature in a shorter time than would be required to bring them up to the same temperature if placed in a fire.

One of the worst features of heating pipes too suddenly with steam is the water hammer, and aside from the liability of this to start joints to leaking, is its liability to fracture fittings, causing them to subsequently give way with perhaps disastrous results. To the credit, however, of ordinary wrought iron pipe and fittings, it can safely be said that they will nearly all stand five or six times their legitimate working strain, and while we frequently find faulty ones, the average quality as to strength is remarkably high.

As to the drainage of heating coils, the practice has been more, and is still much in vogue, of using a check valve of more or less range of opening, usually seldom changed and absolutely impossible of manipulation to meet the varying demands for the outlet of the water, which varies frequently and suddenly in amount, with the variation of pressure in the coil, the amount of water carried in by the steam, the condition of the coil as to cleanliness, thus making it a better or worse condenser, the relative temperatures of the liquid handled and of the steam used, etc. The check valve is practically a fixed opening for a variable duty, and is of course illogical.

Another method of controlling outlets is by having a valve with handle and full range of opening, having the outlet discharge sometimes in view. This, while better than the comparatively inaccessible check valve, is very far from performing the work of allowing the escape of water and of no steam successfully.

The worst feature of the ordinary check valve is that when steam is first admitted and a large opening demanded for the escape of the copious condensation, the opening remains the same as later, when there is probably not half of the water to be disposed of. Then, when the liquid is well warmed up, and condensation is much slower, the check gets in its work on the coal pile. Further, an opening which suits the coil when clean is much too large when the coil is foul.

The steam trap, as a means of coil drainage, is probably superior, all things considered, to any other method used, for the special reason that if in proper order, it will almost instantly adapt itself to any variation of duty within its range. Almost all traps will drain heating surface immensely beyond their rated capacity, which capacity depends on the size of the outlet pressure carried in the coil (and of course in the trap), and the resistance, if any, at the outlet. The office of the trap is, of course, to separate the water of condensation from the steam, allowing the water to escape, and closing its own valve or valves (which are usually balanced), usually by means of floats geared to the valves by levers, and in case of gravity traps operating the valves by the accumulation or discharge of a given weight of water. The theoretical working of nearly all traps is by pulsations, the accumulated water raising the float, which is often a float pure and simple, and sometimes a substance heavier than water, advantage of whose difference in weight in and out of water is taken to open the valve on rising into the water, and closing it by the fall of the water in the chamber, all the valves usually closing completely shortly before the water line has reached the discharge line of the valve.

To prevent the escape of steam, the pulsations of the trap are variable as to time, and are governed by the rapidity of condensation, the buoyancy of the float, the size of water chamber, and the sensitiveness of the valve gear.

For reasons within themselves, steam traps (and their name is legion) will not do half work. They will either swim and work or sink and stop. The frisky little steam pump will make you think it is pulling awfully hard, and may be doing nothing, and stop when your back is turned. The steam trap is not built that way; it gets on one side of the fence (although it may be the wrong side) and stays there till further orders. As to automatic coil drainage with traps, it fortunately happens that while the time occupied in a given evaporation work is lengthened, the full economy of the process is not changed except by the slight loss by the increased time for radiation. In sugar house work the question of getting the stuff out of the way and the work along is usually the important one.

It seems beyond question that the use of the steam trap is one of the most important steps in fuel economy we have in connection with heating coils; also that they are somewhat more complicated than a coffee mill, and not quite so well understood. The number of traps out of employment in Louisiana sugar houses is evidence of this. A few of what seem to be the elementary requirements in placing traps to coils may not be amiss. A trap must receive its water promptly by gravitation from the coils, it having no inducing action whatever on the water. If this fails, the trap fails, or is reputed to fail, and is set up behind the blacksmith shop, the open tail pipe is substituted, the result is better boiling, because you use steam to blow the water out of the coil, but the economy gets away unless the time was worth more than the coal. The "I told you so" is now on top.

The drains from coil to traps should be much larger than if open pipes are used, as only gravity comes in play to drain the coil, and small pipes are liable to become clogged with cement and other small stuff from coils. It is desirable for all outlet pipes and coils to have a dirt pocket in the pipe between the check, or trap or pump, and the coil to collect sediment, which may thus be easily removed. Further, no trap can successfully drain two coils with different pressure, as the one with lowest pressure cannot discharge its water till it becomes full of water or the pressure rises. Each coil should have its own independent trap or pump, because, for instance, take two different worms with steam on alike; one coil is larger and cleaner, or say, simply cleaner, and its value as an evaporator is 10, the value of the foul one is 8, each one with its own trap or pump, their combined value is 18. Now put both to the same trap or pump. The cleaner one being much the best condenser, will constantly tend to lower its pressure below the other similarly supplied with steam, with the result that it will with difficulty discharge its water, and only intermittently. This lagging back will cause it to only discharge as much water as the foul one, with the result that their combined value is 16 instead of 18.

There are now very perfect pumps on the market for pumping direct from coils to boilers, and they seem to be giving good satisfaction. The difficulty has principally been in the regulation of these pumps, as they mostly object to pumping steam back into the boilers, probably because this is of no use. Some of these machines, however, are provided with elaborate regulating apparatus to carry away only the water as supplied from the coils. It would seem that if each coil had its independent drain the cost would stand in the way of the pumps. The French savants, from their experiments on sleeping water, etc., seem to object to returning water to the boilers without airing. So far, however, we have no recorded instance of damage to boilers directly traceable to this cause.

In connection with open outlets and traps it may be meentioned that they will deliver their water to any height, due to the pressure in the coil.

ALLAHASSETT.

* From the Louisiana Planter.

HARRISON'S ELLIPTIC CYCLE GEAR.

THE engraving illustrates a form of treadle gear with sun and planet elliptical gear, as arranged for use on a bicycle by Mr. J. Harrison, of Grantham. Machines fitted in this way have been made by the Grantham Cycle Company, and the engraving herewith shows the machine so fitted and exhibited in London at the last cycle show, with which want of space prevented our dealing. The Harrison gear dispenses with a chain, and it secures variable velocity ratios between pedal and wheel tread. We have to admit of a decided preference for the chain over any other gear for this work, but some of our readers may be interested in the elliptic gear and treadles, nevertheless. We have ridden a machine geared in this way to about 76 in., and found that it worked easily, although with such high gear, but such a trial needs to be of some considerable duration to be of service, and ours was not. The view given simply shows the driving wheel, the rear part of the frame, and pedals.—The Engineer.

NEARLY forty thousand tests by the forestry division of the United States Department of Agriculture have established these facts: Seasoned timber is twice as strong as green, but weakens with absorption of moisture; large and small timbers have equal strength per square inch if equally perfect; knots weaken a column as well as a beam.

TRIPLE EXPANSION CORLISS ENGINE, FRIKART SYSTEM.

AMONG the many engines exhibited at the Paris Exposition of 1889, the three cylinder triple expansion Corliss engine, of 600 horse power, built on the Frikart system, attracted great attention. The same engine was exhibited at the Antwerp Exposition of 1894. Fig. 1 is a general view of the engine, showing the entire valve system. Fig. 2 shows the connections of the eccentric rod, admission valve, and governor. Fig. 3 is a detailed view of the valve itself. A bent lever, a b, is fastened on the shaft, o; it carries a finger, b c, which rests on the cam, e o, which is keyed on the shaft, o. Starting from the dead point, the lever, a b, is put into motion by the eccentric bar

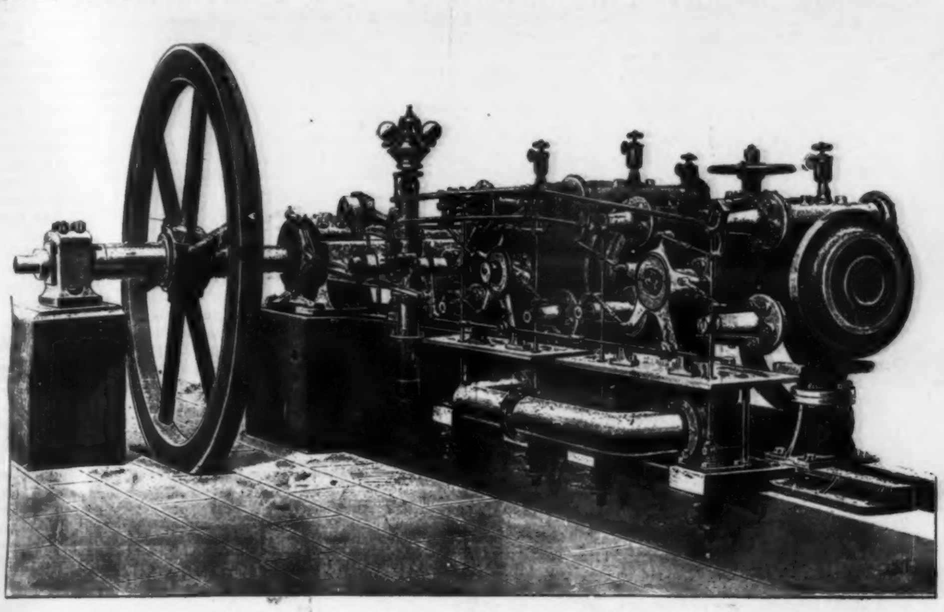


FIG. 1.—CORLISS ENGINE OF 600 HORSE POWER, BUILT ON THE FRIKART SYSTEM.

carrying b c, which presses on the cam, e o, and opens the valve. The movement takes place when the point, i, reaches the point, k, the curve, M, being described by the point, i. The cam will then be forced by the pressure of the steam into a position of repose. As shown in Fig. 2, the eccentric bar, of which the point, A, describes an ellipse, controls the piece, B C D, which carries, at D, an arc of a circle, c g, to which are secured the two triangles which control the admission valves, these triangles working the levers, b d. D is connected with the governor by means of a lever, D f E, the point, f, describing an arc of a circle around the point, E. The points, c g, follow the movement of D, and each of the triangles is given movement resulting from the oscillations of B C D. The governor can be adjusted at E, to control the engine.

This engine is somewhat similar to the Sulzer type, and permits of regulating the admission from 0 to 75 per cent. of the stroke. If, as in many engines, the closing of the admission valve is only at the end of the stroke, it produces a considerable augmentation of speed, which is sometimes dangerous. The triple expansion engine exhibited at Antwerp had the following dimensions:

	Meter.
Diameter of the high pressure cylinder..	0·40
" " intermediate " ..	0·60
" " low pressure " ..	0·95
Stroke....	1·25

The working pressure is 10 kilogrammes, and the engine makes 80 turns a minute. As shown in Fig. 1, the high pressure and intermediate cylinders are placed in tandem, the low pressure cylinder is connected by

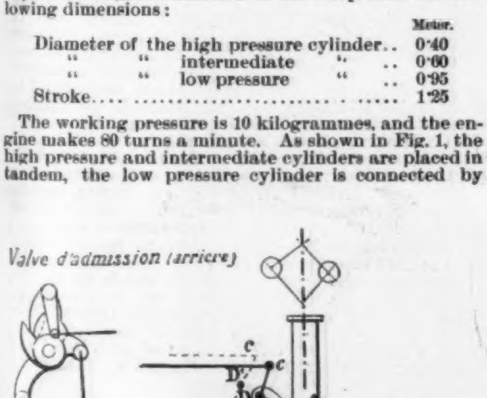


FIG. 2.

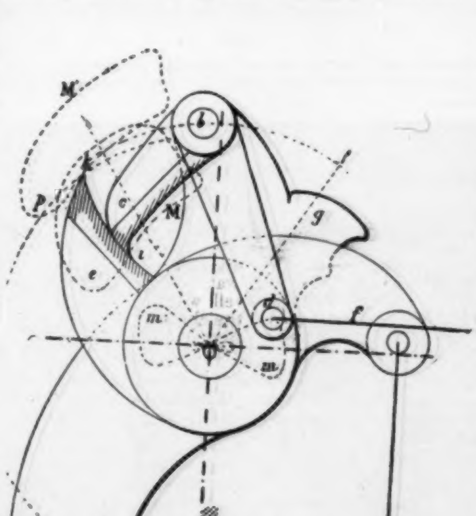


FIG. 3.

means of a crank, and is on the other side of the flywheel, the condenser and the air pump are placed behind it on the same line. The three cylinders are enveloped in steam, the steam being taken from the boiler for the high pressure cylinder, and from the intermediate reservoir for the others. These intermediate reservoirs are under the floor, and the water of condensation is removed by three pumps and returned to the boilers. For the foregoing particulars and for our engraving, we are indebted to Le Genie Civil.

FOUNDATIONS IN QUICKSANDS.

THE method of excavating, or taking out so many hundreds or thousands of tons of one description of material, to replace them with an equivalent quantity of another description, in order to obtain foundation for an engineering work of magnitude, is a tedious and laborious operation. Not only does the difficulty augment in the direct ratio of the depth—especially in cases where the piers and abutments, if the work take the form of a bridge, are founded under water—to which the foundations must be sunk, but the cost increases enormously in proportion to the same dimension. One mode of escaping the necessity of taking out stuff and filling in again is probably the oldest employed, and that consists in driving piles into the substratum, which they tend to consolidate, cutting off their heads at the level required, laying a strong timber platform or floor over the whole area, and starting the superstructure upon it. There is, nevertheless, some amount of excavation and refilling even under these conditions, for it is usual to take out all the loose earth for, at least, 3 ft. or 4 ft. below ground level, and fill in with solid cement concrete, well rammed and punned, upon which the footing courses are commenced. Simple and undoubtedly useful as this system of getting in foundations is, it has several serious drawbacks. It is, in the first place, slow, whether the ordinary "monkey" be used for driving, or whether steam, air, or gunpowder be the means of obtaining the necessary pressure in the pile engine. The use of timber piles is also very much restricted by the nature of the ground and the number needed. It may be mentioned that the difficulty of driving the necessary number of piles 30 ft. deep into the London clay would of itself have forbidden the construction of timber coffer dams, instead of iron caissons, for the building of the piers of Tower Bridge. As it was, timber coffer dams were strictly prohibited by the clauses of the act of Parliament authorizing the undertaking.

When piles are got down through sand by the aid of jets of water, a plan adopted for the first time by the late Sir James Brunlees, many years ago, the allegation of slowness does not apply. Piles were also sunk in this manner in the extension of the harbor works at Calais, and, as will be pointed out, the method is susceptible of many and various applications to the getting in of foundations generally. The operation is very simple, and can be described in a few words. A pipe between 2 in. and 3 in. in diameter is attached to the side of the pile, and connects with a pump. The pile having been pitched, water is forced through the pipe underneath the bottom of the pile, and by loosening the sand until it attains the necessary degree of fluidity, causes the pile to descend with extreme facility and rapidity until the proper depth is reached. When the pile is "down," the feed pipe can be detached, spiked on to another, and the operation repeated. So great is the accuracy and the certainty of this "washing-out" process, that it is a common practice to make the holes for the bolts in the piles before they are got into position. It is stated that in this manner piles can be got down at the rate of about 10 ft. per minute under fair conditions. Those who have had experience in the driving or sinking of piles in foreshores or river beds are aware that it is by no means an uncommon occurrence to come across sunken pieces of wreckage, bowlders, and other obstructions, both natural and artificial, which it is absolutely necessary to remove before any further progress can be made. By passing a pipe underneath the obstacle, and turning on the water, it is speedily cleared away, without any knocking of the pile out of position, battering the head to pieces, or breaking it off short, and thus necessitating the always troublesome and unpleasant task of drawing it. After the pile is down, and a reasonable time allowed for the churning up of the sand to subside, it recovers its solidity and grips the pile so tightly that it becomes well nigh impossible to "start" it again. It is not difficult to perceive that the system of Sir James Brunlees can be equally well applied and has been applied to the sinking of caissons and cylinders when circumstances permit of it, which, however, is not very frequently. A big cylinder would require a greater number of jets of water and of pipes, and probably a greater head or pressure of water. But the difference is, after all, only one of degree, and not of principle.

The conditions of the examples to which we have drawn attention become completely inverted, when, instead of its being necessary to impart a certain amount of fluidity, or at least plasticity, to the substratum, the latter possesses it to a degree so excessive as to require artificial agglomeration and consolidation in some form or another. It is, in fact, a case of dealing with a quicksand, a description of foundation which, from time immemorial, has invariably constituted one of the most difficult constructive problems which has ever engaged the attention and taxed the professional skill of those engaged in engineering and architectural works. Several attempts, evincing considerable ingenuity and knowledge as well of the whole subject, have been put forward at different times to affect a satisfactory solution of the question, which it will be interesting and instructive to refer to. One method of dealing with the difficulty was the "Poetsch" freezing process, which, on a limited scale, was attended with some measure of success, and for a while was regarded by many able judges as the only available mode of treating subsoils of so treacherous and shifting a character. Briefly, the modus operandi was as follows:

A large number of pipes were distributed as uniformly as circumstances would allow in and about the unstable site. They were filled with a powerfully freezing liquid, which was maintained in a constant state of active circulation, with the result that in a short space of time the quicksand became solidly frozen. There are two strong objections to this mode. One is that, after the freezing process is discontinued, the sand returns to its primordial condition, which is not one of stable equilibrium and conducive to the permanency and stability of the work, as was exemplified in the application of the Brunlees principle. On the contrary, the quicksand rapidly thaws again, and becomes as unstable as before. It is true that it may be possible during the continuance of the congelation to get in a fairly secure foundation, but the risk is great; and, what forms the second objection, the cost of the whole refrigerating plant, machinery, and appliances is excessive.

Another method of accomplishing the same result is known as the "Neukirch" system, which similarly dispenses with all dredging or excavating of the layer of sand or of sandy gravel, and aims at converting it into a solid mass of concrete by its own automatic agency in the following manner:

By means of compressed air machines cement or hydraulic lime, in a state of powder is forced into the sand at a pressure which causes it to form a very intimate mixture, combining with it, and resulting in the creation of a rough but strong cement concrete. So thoroughly is the permeation and saturation of the sand accomplished, that after the forcing operation is relinquished, the particles of sand, if brought into contact, adhere to one another with the greatest pertinacity and energy. It is well known to those who are conversant with the making of concrete, whether by hand, mixer, or mill, that the product occupies a less volume than that of the sum of the ingredients when free and uncombined. Experience has shown this rule to be strictly adhered to in treating concrete by the Neukirch plan, in which the proportions of the two ingredients are one part by volume of cement to five parts of sand, measured in the same manner. The area of the foundations, or what is equivalent, the area of the sand to be thus treated, is defined and separated by an ordinary timber casing, exactly as is done in tipping boxes of concrete under water in the building of a pier. As the caisson is intended to last only while the concrete is setting, it may be removed afterward; but as a rule it is left in the ground. It is not worth while, for the sake of the old timber, to run the risk of drawing the main and sheet piles, and possibly damaging the permanent work.—The Building News.

IT is said that the first cost of building a fleet of Atlantic liners is a trifle compared with the cost of running them. In less than three years it exceeds the cost of construction, so enormous is the constant expenditure in wages, port dues, and repairs.

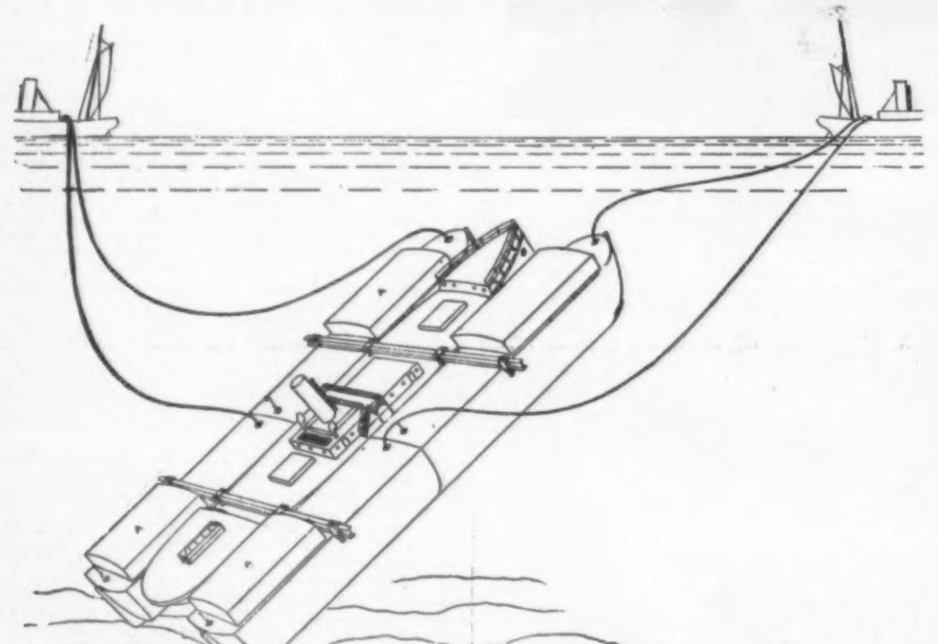
SYER'S APPARATUS FOR RAISING SUNKEN SHIPS.

The question of raising sunken ships is a matter upon which a very small proportion of the community can claim to have any special knowledge or be experts in. Among the methods usually adopted to carry out this operation, two may be taken as the typical and only practical methods that have been successfully employed. The one method is the raising of the vessel by means of camels, or vessels at the surface of the water, and ropes or hawsers passing round or attached to the sunken ship, and made fast to the camels or vessels on the surface of the water; and the other method is the building of a coffer dam from the vessel to above the surface of the water and pumping the water from the space inclosed thereby. It has long been known that the disadvantages attaching to the first method, among others, are—the danger of the camels capsizing if allowed to sink too deep in the water; the great length of hawsers required for attaching in deep water; the dependence on the rise and fall of the tide; the liability of the hawsers to break by the strain produced by the motion of the water at the surface; and lastly, the inability to raise a large sunken ship to the surface of the water. The second method is only applicable when the sunken ship is in shallow water, and is very costly to carry out.

We bring to notice a novel apparatus for raising sunken and stranded ships, which has been invented by Mr. W. Syer, of James Place, Old Trafford, Manchester.

The invention consists of two sinkable and raisable iron submarine vessels, which are perfectly controllable, and which are adapted to operate under two strong steel girders placed transversely across the deck of a sunken ship, to which they are attached in a most simple and efficient manner.

This submarine vessel is constructed somewhat in the form of a canal boat with an air tight deck, and having an air tight bulkhead across the middle extending from under the deck to the keelson, thus leaving two vast chambers, one in the fore and the other in the after part, either of which can be filled with water or emptied independently of the other.



APPARATUS FOR RAISING SUNKEN VESSELS.

On the deck of the submarine vessel fore and aft are constructed two permanent air cases or air receptacles of such dimensions as not to prevent the vessel from sinking when its chambers are filled with water, although they are of sufficient dimensions to retain its deck uppermost when submerged, thus rendering the submarine vessel non-capsizable and exceedingly buoyant when resting at the bottom of the water.

When the submarine vessels are required to be raised, the water is driven out of the chambers by the application of air, which is forced down a pneumatic hose in a similar manner as is done in the case of a diver.

By regulating the admission or escape of air through the pneumatic hose, the ends of the submarine vessels can be raised or lowered to any convenient angle with the greatest nicety, and they are, we are informed, capable of being easily moved to any required position by means of their great buoyancy.

The construction of the submarine vessel is on such lines as to render it perfectly navigable when floating on the surface of the water; it can be operated (irrespective of tides) in any depth of water where divers can work, and can be constructed of such dimensions as to be capable of raising ships of very large tonnage. —Marine Engineer.

THE BALTIMORE AND OHIO RAILROAD TUNNEL AT BALTIMORE.

I.

The new belt line tunnel in Baltimore, on the main line of the Baltimore and Ohio Railroad through the city of Baltimore, was undertaken to give this railroad a clear route through to the North. Previous to its completion all trains on the Baltimore and Ohio Railroad running between Baltimore and the North were compelled to take a devious course, and were transferred to a ferry running between Locust Point and Canton. The delay which this water transfer entailed acted for many years to the great disadvantage of the company, as other lines had a clear all-rail route through the city. To do away with this delay, the Baltimore and Ohio Railroad secured legislative permission to construct a tunnel under the city, and in September, 1890, work was begun upon the tunnel and line which now runs from Camden Station, in the heart of the city, north, and then east to Bay View Junction, a distance of 7·2 miles.

To construct this road the Belt Line Company was formed, and the actual construction of the tunnel and line was successfully carried out by the Maryland Construction Company, a company formed for that purpose. The tunnel is one of the longest soft earth tunnels ever driven, and runs through the center of the city, immediately under Howard Street, one of Baltimore's principal thoroughfares. The length of the tunnel is 7,339 feet, and the maximum dimensions, after lining, are twenty-seven feet wide by twenty-two feet high. Its cost ready for the track is set down at $225 a lineal foot.

II.

With the project for the construction of the tunnel the question of its ventilation became urgent. The disadvantages of its operation by steam locomotives were patent, and it became necessary to find a means of doing away with the smoke and gases either by a scheme of ventilation or the abandonment of steam locomotion in the tunnel. Cable traction was suggested and other schemes, but all in turn were rejected as inadequate or unsatisfactory. The General Electric Company then offered to undertake the construction of electric locomotives of capacity sufficient to haul the heaviest trains, effect the entire equipment of the system, both for lighting and power, and thus to solve the ventilation problem. This the General Electric Company has accomplished, and the success of the electric equipment stands to-day as one of the most remarkable examples of electric engineering ever undertaken.

Briefly, the electrical equipment and the work as first outlined was as follows: The locomotives were to operate from Henrietta Street about 1,800 ft. in the open to the portal of the tunnel at Camden Street, and thence to the further end at Mount Royal Avenue, and for 4,600 ft. further on in the open, or a total distance of about 14,500 ft. The locomotives were to join the rear end of passenger trains going north at Henrietta Street and push both cars and locomotives through to the second station, from which point the steam locomotive was to do all the hauling. Freight trains were to be pushed the entire distance. The calculations were to be based on a maximum weight of 500 tons for each passenger train, including the steam locomotives, with a speed of thirty-five miles an hour, and on a maximum weight of freight trains of 1,200 tons at a speed of about fifteen miles an hour, on a grade of 0·8 per cent. The number of trains each way was to be about 100 a day. An electric lighting plant with large incandescent lamps for the tunnel, and arc lights for the stations, was also contemplated.

III.

The power house stands upon the west side of Howard Street, east of the tracks leading to the southern portal, and between Henrietta and Montgomery Streets, two blocks south of the Camden station of the Baltimore and Ohio Railway. It is a one story building rising thirty feet from floor to eaves, with walls of brick one foot five inches thick. The roof of slate is supported on iron trusses, and the building is practically fireproof. It is divided into two parts, the engine room occupying the north portion, being separated from the boiler room by a brick wall. The entire length of the building is 322 ft. 1 in. long; the dimensions of the engine room are 223 ft. 10 in. in length by 57 ft. 9 in. wide, and of the boiler house 98 ft. 3 in. by 69 ft. wide.

The boiler house is a spacious and lofty room, having twelve boilers (250 H.P.) arranged in six batteries, three of which are placed on each side of the center passage. It is lighted from the roof. The boilers are of the Root water tube type, made by the Abendroth & Root Manufacturing Company. Each boiler is twelve tubes wide and eleven tubes high with six 14½ in. drums and a 30 in. steam drum. Space is left for an additional boiler on the west side of the room.

A system of mechanical draught is employed with two fans of the Sturtevant pressure pattern. Each fan is belt-driven by a ten horse power vertical engine, set up on the floor of the boiler room, and one is of sufficient capacity to secure the necessary draught.

The boiler room is further equipped with a C. W. Hunt coal crusher and conveyor, which brings the coal to the boiler and carries away the ashes from the ash pits; with Dean duplex feed water pumps, and a 3,000 H. P. Webster feed water heater.

The steam system is duplicate throughout, and was laid out in the engineering department of the General Electric Company. Sudden demands for steam likely to be made at times necessitated special provision to take care of any water that might be siphoned over from the boilers into the system. The mains from the boilers are, therefore, placed high enough to allow the water to drop into the separators, whence a "Lux" drip system returns all water from this point back into the boilers by gravity, and prevents its passage into the engine room system. Each main is provided with a forty-eight inch separator. A novel addition to each boiler is the angle check and stop valve which shuts off automatically from the system any boiler in which a tube has given way, or any part of which has met with an accident.

The engine room is divided into two sections, one devoted to the power plant, the other occupied by the lighting generators. In the power section space has been provided for five direct connected engines and generators, and four are now in place. The engines are horizontal, tandem compound Reynolds-Corliss machines, from the shops of E. P. Allis & Company, and have 24 and 40 × 42 in. cylinders. Directly coupled to them are 500 k. w. General Electric multipolar generators, adapted to run with the engine at 110 revolutions per minute. The armatures of these generators are "overhung" on the outer end of the shaft, differing in this respect from the regular practice of railway generators. The armatures are wound for 700 volts potential, and are of the ironclad type, i. e., the windings are embedded in slots cut into the outer periphery of the laminated armature body. The armatures are of the latest barrel-wound type and the machine compounds from 600 volts no load to 700 volts full load.

IV.

From the railway generators the current is brought over cables of 1,000,000 c. m. cross section, to a switchboard of white marble, erected on a platform raised at the south end of the engine room. This switchboard consists of four standard "K" generator panels, each equipped with all the necessary instruments for controlling and measuring the current from one generator. The machines are protected from accident arising from short circuit by automatic circuit breakers, one of which is fixed to the upper part of each panel.

The northern section of the engine room contains the lighting plant, consisting of eight fifty-light Thomson-Houston arc generators and two alternators for the incandescent lamp service in the tunnel. The arc light machines are belted to two cross compound Armington & Sims 250 horse power engines, 16½ × 23 × 19 in. Two other engines, of similar make and capacity, drive the two alternators, and space has been left for an additional engine and alternator. Each alternating generator has a capacity of 2,000 sixteen candle power lamps, and as the tunnel is lighted by 1,000 thirty-two candle power lamps, one alternator will suffice for the present illumination of the tunnel. Facing the lighting plant, on the east side of the room, is the lighting switchboard, also of polished white marble. It consists of one standard, twenty circuit, arc lamp plugboard to which only sixteen circuits are at present connected; three alternating generator panels, one of which is left blank, and one feeder panel. The arc lamps used in the illumination of the power house are of the Thomson 1893 type. In addition, it is lighted by clusters of three incandescent lamps each, fixed to the walls. The approaches and stations are lighted by Thomson-Houston standard arc lamps.

From the positive bus on the railway switchboard, eight cables of stranded copper, each of 500,000 c. m. cross section, or a total cross section of 4,000,000 c. m. pass to the overhead structure immediately outside the power house, where connection is made to three feeder cables, of 1,000,000 c. m. cross section each, and to the overhead conductor itself, which has an equivalent of 1,000,000 c. m. cross section. The negative bus is similarly connected to the rails, which are double bonded with No. 0000 wire, and also to the return cables laid in a wooden box between the tracks. Perfect contact between bonds and web is obtained by using a hollow rivet on each end of each bond and expanding it, when inserted in the rail by means of a conical steel pin.

V.

The distance over which the electrical locomotives will operate is about 15,000 ft., passing through two tunnels, 7,339 ft. and 265 ft. long respectively, and over 7,396 ft. of track in the open from Hamburg Street to Huntington Avenue. Three tracks are laid into the southern portal, two tracks passing through the tunnel, four tracks from the northern portal, through the Mount Royal Avenue arch, and two tracks as far as Huntington Avenue, where a siding is provided for the electrical locomotives. There is a steady grade of 0·8 per cent. from the southern through to the northern portal, and the lines in the open have two equated curves of 10°, with a steady gradient of 1½ per cent. At the power house end of the line the locomotives run on a siding at the beginning of the long open cut running down to the southern portal.

The operation of the freight trains will begin at the main tracks south of the Camden station, where they will be switched into the cut. The electric locomotive will then couple on behind, without stopping the train, and push it through as far as the Mount Royal Avenue portal, a distance of 8,146 ft., the steam locomotive doing no work. After passing out of the tunnel, both steam and electric locomotives pull and push together up the heavier grade as far as Huntington Avenue, the average speed over the entire distance being about fifteen miles an hour. At Huntington Avenue

the electric locomotive will uncouple and run into its siding.

The plan of pushing the passenger trains through the tunnels has been abandoned, in view of the possible results if one of the cars or the steam locomotive should leave the track, in front of the heavy electric locomotive traveling at thirty miles an hour. The passenger trains will, therefore, be pulled through from the Lombard Street station near the south end of the tunnel to the Bolton Street station at the north end.

VI.

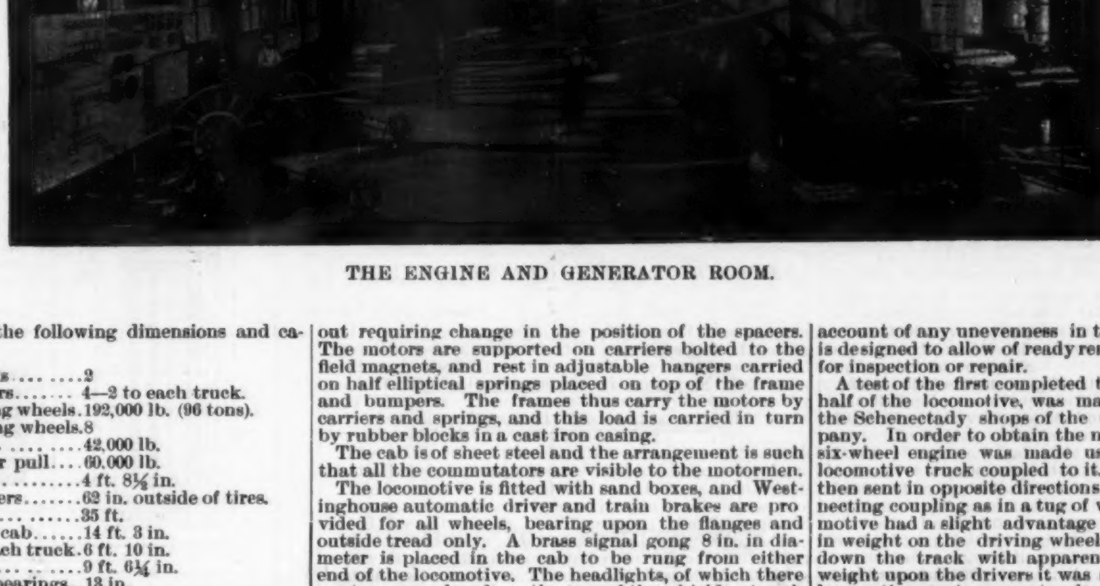
The 96 ton locomotive, built by the General Elec-

THE ENGINE AND GENERATOR ROOM.

tric Company, has the following dimensions and capacity:

Number of trucks	2
Number of motors	4—2 to each truck.
Weight on driving wheels	192,000 lb. (96 tons).
Number of driving wheels	8
Drawbar pull	42,000 lb.
Starting drawbar pull	60,000 lb.
Gage	4 ft. 8½ in.
Diameter of drivers	62 in. outside of tires.
Length over all	35 ft.
Height to top of cab	14 ft. 3 in.
Wheel base of each truck	6 ft. 10 in.
Extreme width	9 ft. 6¼ in.
Diam. of sleeve bearings	13 in.

The driving gear consists of a cast steel spider shrunk on and keyed to a cast steel driving sleeve, having a tensile strength of not less than 80,000 lb. Each arm of the spider is provided with a double rubber cushion, with a chilled cast iron wearing cap, the cushion being forced into the arms of the spider and the cap. The eight driving wheels are of cast steel pressed and keyed to the axles, and have tires 3 in. thick at centers of tread shrunk onto the wheel centers. The driving axles are of special open hearth steel. The journal bearings are outside the driving wheels and allow of



THE NINETY-SIX TON ELECTRIC LOCOMOTIVE—THE GENERAL ELECTRIC COMPANY, BUILDERS.

easy access to all parts of the truck frame and driving box. In the design of this are embodied the good features of the steam locomotive driving box and passenger car box.

The two opposite side frames of each truck rest upon four wheels, each consisting of one piece of hammered wrought iron, 3¼ in. thick, to which the frame jaws are welded, and protected from wear by cast iron shoes, and are connected together at the ends by heavy forged iron plates, with oak bumper beams between them.

The drawheads are of the Janney type, similar to those used on the Baltimore and Ohio passenger locomotive tenders, and are made of cast steel with wrought iron knuckles. In coupling with freight trains the ordinary link and pin will suffice; but for passenger service the Janney couplers, with which each locomotive is provided, are used. The front and back of the locomotive is provided with safety chains, and in addition to the regular couplings, between the trucks, safety links are used. The buffers between the motors act as spacers for, and fit between plane surfaces in, the field magnets. These spacers have a complete freedom of movement which allows the field magnets to rotate when the motor is in action. These buffers and spacers are so placed as to permit the interchange and reversal of the positions of the field magnet without requiring change in the position of the spacers. The motors are supported on carriers bolted to the field magnets, and rest in adjustable hangers carried on half elliptical springs placed on top of the frame and bumpers. The frames thus carry the motors by carriers and springs, and this load is carried in turn by rubber blocks in a cast iron casing.

The cab is of sheet steel and the arrangement is such that all the commutators are visible to the motormen.

The locomotive is fitted with sand boxes, and Westinghouse automatic driver and train brakes are provided for all wheels, bearing upon the flanges and outside tread only. A brass signal gong 8 in. in diameter is placed in the cab to be rung from either end of the locomotive. The headlights, of which there are two, are placed on the top of the shields at each end, and are twenty-three inch lights of Baltimore and Ohio standard pattern. One shield also carries a Baltimore and Ohio standard whistle, blown by compressed air. The other shield carries a standard bell, operated by an automatic air pressure bell ringer. The locomotive is painted with the standard color and design of the Baltimore and Ohio Company.

VII.

The gearless motors are four in number, two to each truck, flexibly supported and transmitting their power to the wheels through the flexible connections described above. They are of pyramidal shape, are the largest railway motors in the world and, while ponderous in appearance, are by no means so bulky as might be expected from the heavy work they have to perform. Each has six poles and six sets of carbon brushes, the brushes being connected to a yoke revolving through 360 degrees to facilitate accessibility to them. It is possible to remove four brushes without disabling the motor. The field spools are incased in sheet iron cases and fitted over the pole pieces bolted to the field frame. The armatures are built of sheet iron laminations, and are series drum wound ironclad. The armature, with the commutator, is mounted upon and keyed to the hollow sleeve which is carried on the journals on the truck frame. The inside diameter of the sleeve is about two and a half inches larger than the axle. The entire motor is practically fireproof. Each motor is rated at 360 H. P. and takes a normal current of 900 amperes.

When normally placed, the motor rests in a position concentric to the axle, the clearance between the axle and the sleeve allowing of a flexible support. The interposition of the rubber cushions, through which the torque of the armature is transmitted to the driving wheels, allows the armature to run eccentric to the axle when the motor departs from its normal position on account of any unevenness in the track. The motor is designed to allow of ready removal of the field frame for inspection or repair.

A test of the first completed truck, representing one half of the locomotive, was made upon the tracks at the Schenectady shops of the General Electric Company. In order to obtain the necessary load, a heavy six-wheel engine was made use of and the electric locomotive truck coupled to it. The machines were then sent in opposite directions and tugged at the connecting coupling as in a tug of war. The electric locomotive had a slight advantage over the steam engine in weight on the driving wheels, and pulled it up and down the track with apparent ease. For the same weight upon the drivers it was shown that the electric locomotive starts a greater load than the steam locomotive. The pull being constant throughout the entire revolution of the wheel, the difficulty of variation of pull with the crank angle, as in the steam locomotive, is eliminated. The test also proved the driving mechanism and armature couplings amply strong to transmit the torque of the armature to the axle. The controlling devices, etc., occupy the interior of the cab. The controller is erected in one half of the cab, and is of the series parallel type. The reversing lever projects through the upper plate of the controller cover. The resistances are placed around the frame beneath the floor of the cab. The locomotive is equipped with a 1,200 to 3,500 automatic circuit breaker and one 2,000 ampere magnetic cut-out, a 5,000 ampere illuminated dial Weston ammeter and one illuminated dial Weston voltmeter. The compressed air for the whistle and brakes is supplied by an oscillating cylinder electric air pump, the air tanks being placed at each end of the complete locomotive. In the cab are incandescent lights.

VIII.

Contact with the overhead conductor is effected by means of a sliding shuttle-like shoe of brass, which

is fixed to a flexible support fastened to the top of the cab. This "trolley" support is diamond shaped and compressible, contracting and expanding as the height demands, and is arranged to lean on one side or the other as the locomotive runs on one side or the other of the overhead conductor. It is, however, rigid in so far as movement forward or backward over the locomotive is concerned. The current is brought to the locomotive by means of cables connected to the shoe and fastened to the "trolley" support.

The conductor is simply a reversed iron conduit or trough erected overhead on trusses in the open, and in the tunnel attached to the crown of the arch. In the open the conductor is directly over the center of the track; in the tunnel over the center line of the space between the tracks. It extends from Henrietta Street on the south to Huntington Avenue on the north, a distance of 15,000 ft. The conductor consists of two 3 in. iron Z bars ⅜ in. thick, riveted to a cover plate ½ in. thick and 11¼ in. wide, and is constructed in sections 30 ft. long. It weighs about 30 lb. per ft. At intervals of 15 ft. inside the tunnel there are suspended from the arch transverse frames, consisting of two 3 in. channels, held together by plates 4 in. wide, and holding four castings into which are fitted conical porcelain insulators. In the masonry of the tunnel are fitted the bolts necessary to support these frames. They are 2 ft. 6 in. long, have split ends, and extend 12 in. into the masonry. The bolts pass downward through the outside pair of insulators. The bolts attaching the conductors to the channel frames pass through the inside pair of insulators and support an iron stirrup in which the conductor hangs. This method affords a double insulation. The height of the conductors above the level of the top of the rails is 17 ft. 6 in. in the tunnel, and they are fixed a little on each side of the center line. This plan was adopted to avoid the risk of the conductors striking brakemen who might be standing on the top of passing freight cars. An additional precaution is provided in the shape of continuous wooden shields fastened to the iron stirrup which supports the conductors.

IX.

Outside the tunnel the height of the conductors above the rails is increased to twenty-two feet. The supporting structure in the open consists of longitudinal catenaries of two chains of iron rods, having a span of 150 ft. suspended from transverse trusses, supported by columns of latticed steel channels erected on either side of the double track. The catenaries pass over the top chord of the transverse trusses and are fastened to a yellow pine timber post, acting as an insulation set therein. From the joints in the catenaries vertical rods are dropped at intervals of fifteen feet to support the electrical conductors. The vertical rods are attached to a casting holding a porcelain insulator, and through this a short bolt passes up to the joint in the catenary. The double insulation is secured by this vitrified porcelain insulator and the timber post passing vertically through the transverse girder. A hood of galvanized iron is fixed to the top of the timber post. At the ends of the line an anchor pier receives the ends of the conductors. The trusses vary in length from 30 ft. to 62 ft., the latter being required to span five tracks. All the iron work was made by the Maryland Steel Company.

Upon the straight track the conductors are suspended from single catenaries, while upon the curves a double catenary is employed, and the conical insulator is inverted and supported in a casting bolted to the two vertical rods which drop from the catenaries. The vertical rods support a channel frame to which are bolted the conductors and the feeder cleats or clamps. Each joint of the conductor is bonded with a Chicago bond of two No. 0000 wires. The feeder cables are of bare stranded copper of sixty-one strands each of 1,000,000 c. m. cross section. These are supported in iron cleats fastened to channel frames riveted to the overhead conductors at points near to the heavier channels to which the conductors are suspended.

The lead-covered primaries for the tunnel lighting plant are carried on posts set on the side of the cut, to the southern portal, where they drop to the tunnel and are carried upon porcelain knobs fastened to wooden blocks bolted to the masonry. At the points of support the cables are armored with wire to prevent abrasion. The secondaries are carried in cleats, also fastened to wooden blocks, similarly attached, and placed on either side of the tunnel about eight feet from the ground and fifteen feet apart. They are, however, staggered, and thus occur alternately at every seven and a half feet throughout the tunnel. Each block carries a lamp at its lower end, and is there cut out so that the lamp socket may be protected from moisture and dripping water from the tunnel walls. The lamps used are thirty-two candle power, fifty-two volt Edison standard incandescent lamps.

[From the Engineer, London.]

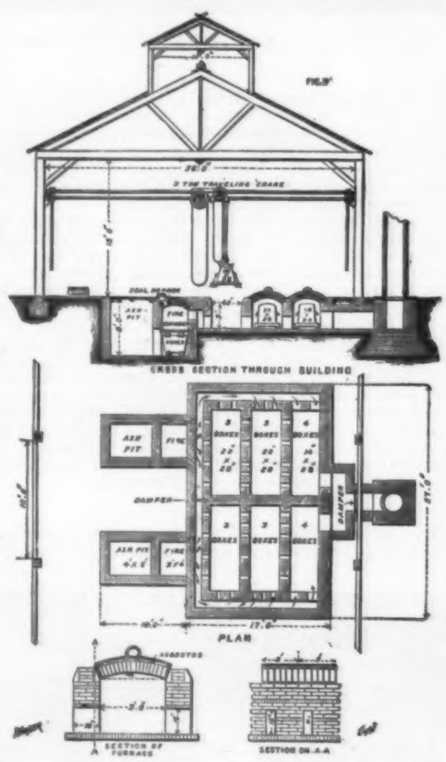
THE TIN PLATE INDUSTRY IN THE UNITED STATES.*

In the Verner design of annealing furnace the charge can be put in and removed without permitting it to cool as in the ordinary style of furnace. There is a bottom weighing about 2,600 lb., with a wrought iron box weighing about the same, and which will hold about ten tons of plates. The charge is inserted through the top, which is movable. The heat enters at the bottom, sides and top, being thus uniformly distributed, and the annealed sheets are said to be softer, of better color, and treated more uniformly than in the ordinary furnace. The annealing takes not more than twenty-four hours.

The drawings in Fig. 11 represent a design for a vertical annealing furnace plant, shown by the Iron Age some time ago, and the following description is condensed from the article in that paper: This new design for an annealing furnace is entirely different from the old styles, the purpose being to charge the furnace vertically by mechanical means instead of horizontally by manual labor. In the latter system, at least six men are required at this arduous work, and they must be expert in handling boxes by means of lever trucks, and must become accustomed to working in close proximity to very high temperatures. In the proposed system, the loaded boxes and bottom plates are hoisted and carried by a traveling crane of about three tons capacity. The box is loaded while standing on a truck at the shears or the operator's bench, and when loaded and covered is transferred to the annealing house, in which there is no obstruction above the floor, and as the furnaces are below the ground there is less loss of radiated heat. The fire is fed by means of a hopper, and is regulated by a rocking grate operated by a lever extending above the floor. The ashes fall into an iron car, which is raised and removed by the traveling crane. The ashpit is 4 ft. by 5 ft., and 8 ft. deep. The furnace chambers are roofed by removable arched covers of brick, with asbestos packing, made in sections 2 ft. long, which are handled by the crane, and are made tight on the seats by a little clay. The furnace is made double, the two parts being worked together or separately; and different temperatures can be maintained if desired.

This is effected by means of dampers between the fire chambers and near the stack or chimney. Great attention has been paid to securing a perfect distribution of heat, and the ports and passages are so graded that the heat can be decreased or concentrated at any desired point by the man in charge, the heat being cut off by placing loose fire bricks in any of the ports. Around three sides of the six heating chambers is a passage 12 in. wide, along which the flames and heated gases travel, entering the chambers by ports graded in size and number so as to produce a perfect distribution of heat throughout the furnace, the ports near the stack being larger or more numerous than those near the fire chamber. All ports are placed at the base of the heating chambers, the equal distribution of heat over the bottom and top of the annealing boxes resulting in uniform ductility and color of the sheets.

The capacity of the furnace shown is twenty annealing boxes, the larger sizes being placed nearer the fire, as they require the most heat. The object of the



design is to effect an economy in fuel and labor without in any way deteriorating the quality of the product, and the first economy is in the mechanical handling. The excavation for the furnace need be only 4 ft. deep except at the ashpit, and that will be the height of the brickwork, while but little wrought or cast iron is required. If good firebrick is used, and the surrounding earth well packed, repairs will be slight and the heat retained.

The building is free from the usual dust and dirt of an annealing house, which are detrimental to the plates. The furnace will burn slack coal, and a fire chamber sufficient for twenty boxes will have an arch of twelve square feet.

After having been annealed the plates are taken to the cold rolls, which in the most approved practice are entirely independent of the hot rolls, which are often placed in a separate room. This is an advantage, as the plates after leaving the hot rolls have to go to the pickling and annealing machines before reaching the cold rolls, so that if both sets of rolls are placed together the steady progress of the plates from one process to another—which insures the best economy of operation—is likely to be interfered with. At the same time the dust and dirt collect on the rolls, which is detrimental to the high finish which the cold rolls are intended to give to the plates. The usual practice is to use hard chilled rolls, 22 in. diameter and 30 in. long, with housings weighing about 14,000 lb. and having double screws.

After the cold rolling the plates are annealed at a lower temperature than that of the first annealing and then treated by the white pickling process, the acid solution for which is much weaker than that for the previous black pickling already described. They are then scoured with sand and water by hemp pads, and well washed.

The plates now reach the tinning house, where they are placed in a troth of clean water ready for use. The tinman takes them one by one, and puts them in a grease pot containing palm oil, and after soaking in this for a short time they are placed in a tinning pot which contains molten tin covered with palm oil. The workman then puts them in another tinning pot, containing more tin, and after they have soaked for a short time he takes them out one at a time, brushes each side, and dips them again into a tinning pot, from which they pass between rolls working in a bath of palm oil. A boy, called the riser, takes the plates as they pass through the rolls and places them in a rack to cool. This is the usual practice, but, as already noted, one company does not employ the tinning rolls, claiming that they are injurious to the quality and durability of the tinned surface.

The Britton tinning machine, shown in Fig. 12, is somewhat on the pattern of the Thomas and White machine, but is said to take less metal and less oil to bring the plate up to the required gage, while it does away with rolls running in the metal. About ten of these machines are now in operation in this country. In the accompanying illustration A is the tinning pot, B the grease pot, and C a curved neck connecting the back of the former with the bottom of the latter. The bottom of B is slightly above the top of A, to prevent so much tin being put in A as to rise above the bottom of the grease pot. This is done to limit the area of the surface of the metal, as oxidation occurs even under the palm oil covering, and also to enable the bottom of the grease pot to serve as a shelf to catch any impurities of the oil. The neck, C, is of such size as to allow the plates to pass freely through it, but at the point where the surface of the molten metal will

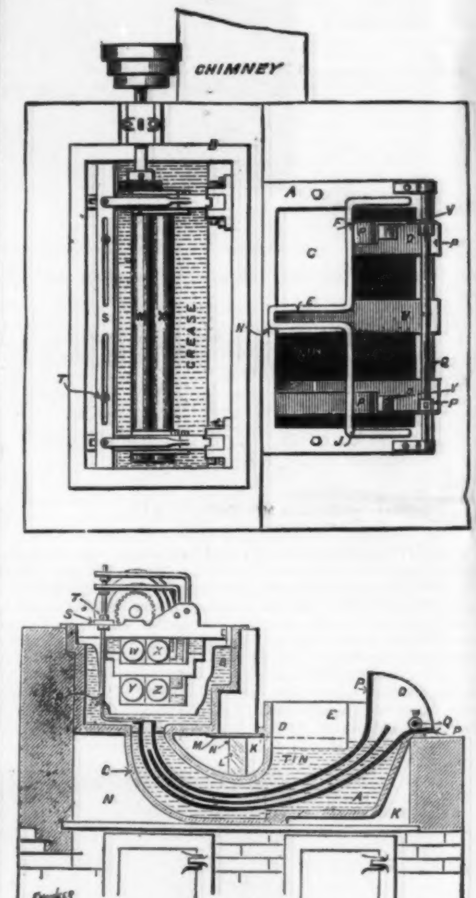


FIG. 12 BRITTON TINNING MACHINE

be—shown by the dotted line, D—the horizontal sectional area is made as small as possible to reduce the amount of oxidation by exposure. To further reduce the exposed surface of the metal in A, a box is formed in one rear corner of the pot by the two vertical walls, E, F, and the horizontal plate, G, all forming part of the pot. At the opposite rear corner of the pot a bottomless box is formed by the vertical walls or partitions, H, J. Palm oil covers the surface of the metal in both pots, that in pot B submerging the lower rolls, but the tin in the bottomless box of pot A is not covered, as from this part is dipped tin to be poured into the rolls. The metal is kept hottest in pot, A. Across the front of this pot is the flue, K, and behind it is another flue, K¹, formed by the brick wall, L, and plate, M. The flues connect with each other at one end of the pot. Similarly, heat for pot, B—from an independent furnace if desired—is conducted through flues, N and N¹. The flues connect with the chimney. The plates which are being tinned are conducted through the tinning pot and the neck by curved guides, O, O, having the top and bottom flanges, P, P, P, P. The front ends of the guides are secured to the transverse bar, Q, and may be moved laterally to fit plates of different widths. The rear ends of the guides are connected to rods, R, passing through slots in the transverse bar, S, and adjusted by the nuts, T. Another guide plate, U, serves as a rest for the front ends of the push rod used to push the plate through the neck. If the plates are to push each other through this neck, a flange, V, is formed on the guide plates between the top and bottom flanges, P, this third flange extending from the front end to within about 12 in. of the rear end. The three flanges form two grooves. In operation the first plate is entered with the left hand side in the top groove and the right hand side in the bottom groove, while the next plate has its left hand side in the bottom groove and its right hand side in the top groove, so that the second plate will force the first one along and cannot pass over it. In the grease pot are two

* Continued from Supplement, No. 1022, page 16340.

TABLE No. 7.—LIST OF AMERICAN TIN PLATE WORKS AND BRANDS OF TIN AND TERNE PLATES, APRIL, 1895.

Name of manufacturing firm.	Black plate mills. Estimate No. 1. Completed and contracted for.	Contemplated or prospective.	Black plate mills. Estimate No. 2. No.	In operation.	Building.	Tinning sets. No.	In operation.	Names of Brands. Bright tin-plates. Charcoal.	Coke.	Terne Plates.	Remarks.
Ætna-Standard Iron and Steel Co.	6	...	8	5	3	8	3	Ætna AA1, Ætna AA, Ætna A, Ætna	Ætna	Belmont, Belmont Extra, Belmont Special	Full equipment in operation by April 15.
American Stamping Co.	...	...	...	...	...	...	...	...	...	...	Operation suspended.
American Tin Plate Co.	16	2	10	10	...	15	15	Imperial, P-e-e-r-l-e-s-s, Premier	Kanner, Koko, Kream	E-l-w-o-o-d, I-n-d-i-a-n-a, L-e-e-d-s, R-e-i-d	...
American Tin and Terne Plate Co.	...	...	...	...	...	...	...	...	...	...	...
American Tin Plate Machine and Manufacturing Co.	...	...	...	...	...	4	4	...	...	Barto, Ætna, †Linfield, Magnona Extra, Mingo, Pencoyd, Sanatoga, †Tandem	†Continuous roofing sheets
Apollo Iron and Steel Co.	...	...	...	...	...	3	1	...	...	Apollo Best Roofing	...
Atlanta Steel and Tin Plate Co.	3	...	3	2	1	8	4	Atlanta	Atlanta	Atlanta	...
Baltimore Iron, Steel, and Tin Plate Co.	4	6	4	4	...	4	4	...	Locust, Oriole	Violet	...
Beaver Tin Plate Co.	4	...	4	...	...	8	...	Beaver	Beaver	Beaver	Expect to begin operations April 10.
Black Diamond Tin Plate Works (H. W. Scattergood)	...	...	...	...	...	4	4	Arrow, Black Diamond, Horse Shoe, Imperial, Peerless, Quaker City	B ◇ D	Arrow, Black Diamond, Horse Shoe, Laurel, Quaker City	...
Blairsville Rolling Mill and Tin Plate Co.	2	4	2	...	...	...	...	...	...	...	Output controlled by Follansbee Bros. Co., Pittsburgh.
Britton Rolling Mill Co.	4	...	2	2	...	3	3	Buckeye, Extra Buckeye	Buckeye	Buckeye	...
Cadwallader, C. W.	...	...	...	...	...	4	4	Petunia, Primrose	...	Optimus, N. F.	...
Canonsburg Iron and Steel Co.	3	...	3	3	...	2	2	...	Flag	Dawn	...
Chicago Stamping Co.	...	...	...	...	...	5	5	...	...	...	Make bright plates for their own use only.
Cincinnati Corrugating Co.	...	...	...	...	...	1	1	...	...	Piqua	...
Crescent Sheet and Tin Plate Co.	4	2	4	...	...	...	...	...	...	...	Building will be ready for operation May 1.
Cumberland Steel and Tin Plate Co.	4	...	4	4	...	...	...	...	...	...	Make black sheets only at present.
Duquesne Tin Plate Co.	...	...	...	...	...	...	...	...	...	...	...
Elwood Tin Plate Co.	...	...	4	4	...	8	8	Bishop Star AAA, Bishop Star AA, Bishop Star A, Bishop Star B	Bishop Star C	Bishop Diamond AAA, Bishop Diamond AA, Bishop Diamond, A, Bishop Diamond B, Bishop Diamond W.B.	...
Elwood Tin Plate Co.	4	...	...	...	...	...	...	Imperial, P-e-e-r-l-e-s-s, Premier	Kanner, Koko, Kream	E-l-w-o-o-d, I-n-d-i-a-n-a, L-e-e-d-s, R-e-i-d	Product controlled by American Tin Plate Co.
Falcon Tin Plate and Sheet Co.	4	...	4	4	...	6	6	Crocus, Hyacinth, Jonquil, Tulip	Violet	Blueflower, Cornflower, Mayflower, Moonflower, Sunflower, Wildflower	...
Filley Tin Plate Co.	...	...	...	...	...	2	2	Adonis, Radiant	Eils, Hero	Admiral, Champion, Fidelity, Filley's Old Style, Filley's Roofing, Union, Victory	...
Follansbee Bros. Co.	...	...	...	...	...	...	...	Blairsville Best Bright, Clifton, Conemaugh	Furnace	Duquesne, Neville, Orbit Old Style, Pittsburgh, Raymond, Scott's Extra Coated, Triumph Old Style	
Great Western Tin Plate Co.	2	2	2	2	1	3	3	Swansea No. 1 Best, Swansea No. 2	Swansea No 3	Cardiff No. 1 Best, Cardiff No. 2, Cardiff No. 3	...
Gummey, Sporing, and Co.	...	...	...	...	...	4	4	Climax, Colonial, Mars, Neptune, Phœnix, Stag, Sun, Victor	Champion	Alderly, Anchor, Climax, Continental, Eagle, Flag, Hercules, Leominster, Liberty, Phœnix, Pennsyl. Old Method, Pioneer, Venus, Waldo, X. L. C. R.	...
Hamilton, John	...	...	...	...	...	3	2	Ivy, Pansy	Pink	Bonus, Fort Pitt, G. A. R., Hamilton's Best Redipped, Hazlewood, Killbuck, Lulu, Mingo Old Process, Osceola Old Style	...
Illinois Steel Co.*	...	13	...	...	...	...	...	...	...	...	...
Irondale Steel and Iron Co.	6	...	6	6	...	8	3	Crane	Crane	Crane Terne, I. S. I.	...
La Bella Ironworks	4	...	...	...	...	...	...	...	...	...	Tin-plate plant building. To be in operation May 15
Lalance and Grosjean Mfg. Co.	2	...	2	...	...	...	...	...	...	...	Tinning department building
Laufman Tin Plate Co.	...	...	...	...	...	4	...	...	...	Allegheny, Freeport, Laufman's Apollo, Tip Top	...
Laufman and Co., Limited	...	...	1	1	...	2	1	...	...	Laufman's Apollo	...
Laughlin Nail Co.	6	...	4	...	2	...	...	Laughlin	Laughlin	Laughlin	Building.
Marshall Bros. and Co.	5	...	5	4	1	8	5	Penn Treaty Charcoal, Penn Treaty AA	Penn Treaty	Girard, Marshall Heavy Coated, Marshall Redipped, Penn. Treaty	...
McDonald and Sons Co.	...	...	...	...	...	2	2	...	...	Eureka, The Jas. McDonald and Sons Co. Old Style	...
Merchant and Co.	...	...	...	...	...	...	...	Florence, Minerva, Palma, Pisa	Leslie	Alaska, Arch, Crescent, Empire, Hand Coated, Hickory, Merchant's Old Method, Merchant's Roofing, Palm, Special Extra Coated	...
Meurer Bros. Co.	...	...	...	...	...	6	6	Howard, Florida	Albert, Brooklyn	Excelsior, Flushing, Grace, Meurer's Old Method, Meurer's Roofing, Pullman, Standard, Superior	...
Monongahela Tin Plate Co.	9	7	9	...	...	...	...	...	...	...	...
Montpelier Sheet and Tin Plate Co.	6	...	6	4	2	12	7	Montpelier	Montpelier	Salamonia	...
Morewood Co.	6	10	6	6	...	12	10	Dorothy, Grace, Jack	R. H. J.	F. W. B. Old Style, H. C. B., J. H. R., P. T. L.	...
Morton Tin Plate Co.	4	...	3	3	...	2	2	Morton	Guernsey	Leatherwood	...
National Tin Plate Co.	4	2	...	...	6	...	...	...	...	...	Building.
New Castle Steel and Tin Plate Co.	16	...	16	6	10	12	12	...	...	...	Large extension now being made to the works.
New Kensington Tin Plate Co.*	6	...	...	...	...	...	...	...	...	...	...
Norton Bros.	...	...	...	...	...	16	16	...	...	...	Make bright plates for their own use only.
Old Dominion Iron and Nail Works Co.	4	...	...	...	4	2	2	Belle Isle, Belmont	Bellevue, Belona	Albemarle, Chesapeake, Green Brier, Indian, Kanawha, Potomac, Rivanna, York	...
Pennsylvania Tin Plate Co.	...	...	4	...	...	7	...	...	...	...	Expect to begin operations next month.
Phillips Tin Plate Co.	...	...	...	...	...	5	5	Century, Oak	Gladys, Walnut	Boston, Columbus, Filbert, F. R. P. Extra, Phillips' Roofing, National, Republic, Zero	...
Pittsburgh Tin Plate Works	2	2	2	2	...	7	7	...	Kensington	Amber, Kensington, Westmoreland	...
Pollock and Co., Ltd.	...	...	...	...	...	1	1	...	...	Blizzard, Curlycue, P. P. P., Unique	...
Record Manufacturing Co.	...	...	...	...	...	2	2	Record Charcoal A, Record Charcoal A1	Record Coke	...	...
Reeves Iron Co.	1	3	1	...	...	...	...	...	...	...	Building.
St. Louis Stamping Co.	8	...	8	8	...	18	15	Granite, St. Louis	Steel Coke	Acme Old Method, Alta, Extra Fine, S. G., S. L. S. Old Process	...
Stickney Iron Co.*	3	...	...	...	...	...	...	...	...	...	...
Simpson (W. T.) and Co.	...	...	...	...	...	3	...	...	...	Boss	...
Somerton Tin Plate Works	4	...	4	3	...	3	3	Somerbrook, Somerton	Somerton	...	...
Star Tin Plate Co.	8	...	...	...	8	...	...	...	...	...	Building.
Taylor (N. and G.) Co.	...	...	...	...	...	22	22	Brilliant, Hand Dipped, Linden, Merion, Royal	Almond, Locust, Mint	Columbia, Genuine Old Style, Globe, Knozall, Maple, Old Method, Spruce, Taylor Roofing Tin, Willow	...
Thomson (A. A.) and Co.	...	...	...	...	...	3	...	...	...	Central, Old Colony, Thomson's Puritan	Operation suspended.
Trotter (Nathan) and Co.	...	...	...	...	...	3	3	...	...	Elziver, Enid, Madison, Sharon, Triumph, Trotter's American New Method, Trotter's Roofing, Trotter's Special, Verona	...
United States Iron and Tin Plate Manufacturing Co.	7	...	5	5	...	12	12	U.S. Bright, Versailles, Youghiogheny	...	U. S. Eagle, U. S. Grant, U. S. Monongahela, U. S. Redipped	...
Wallace, Banfield, and Co.	4	...	4	4	...	10	10	Irondale AAA, Irondale AA, Irondale A, Irondale B	Irondale C	Irondale AAA, Irondale AA, Irondale A, Irondale B, Irondale W.B.	...
Wheeling Corrugating Co.	...	...	...	...	...	...	...	...	...	...	...
Whitaker Iron Co.	2	...	...	...	2	...	...	...	...	...	...
	177	58	140	92	40	277	221				

pairs of driven rolls, W X and Y Z, the line of separation being directly over the rear end of the neck, so that the leading end of each plate will enter between the rolls. Thus only two pairs of rolls are used, as compared with four or more in some other tinning machines; and at the same time the machine is smaller and more compact.

In the Buckman automatic continuous seaming and tinning machine, the black plates are fed direct to the machine from the white pickling tanks. As they pass along, they are scoured with sand and brushed clean by revolving rolls, then washed with water and dried by steam heat. The ends of the plates are then united to form a continuous sheet, and this is passed through a pot of flux and then through the tinning pot, which is covered with palm oil. Working on terne plates, the original machines turned out about 100 boxes per day of ten hours. The machines have been in operation for about two years.

The tinned plates are next cleaned and polished by being rubbed with bran—which absorbs the grease—this work being usually done by machine. In the Record cleaning machine, Fig. 13, the channel-shaped drum, A, is filled with bran, which is kept in place on the inside of the periphery by revolving the drum at high speed, about 2,000 ft. per minute. Within the drum is a series of wheels driven by gearing, and revolving at much lower speed, these wheels carrying a number of steel belts, G, which form the traveling bed for the tinned plates. The belts are $1\frac{1}{2}$ in. apart, and are slightly diagonal to the width of the machine, so that the portion of the plate covered by them changes continually, and the whole surface is thus well cleaned by the bran. The plates are fed in from a table, and pass under the drum. B—being held by the belts, G—over C and under D, being delivered into a pocket at E, from which they are taken by hand and again fed to the machine to have the other side cleaned. The bran is kept stirred up by the metal plate, F. The machine will clean plates of any size or thickness, and has a capacity of seventy-five boxes of plates, 14 in. by 20 in., per day with one attendant. The machine has been in operation regularly for more than a year. The makers inform me that it is patented in England. Finally, the cleaned plates are polished by hand or in a dusting machine, and are then ready to be packed.

All the tinning operations thus far described have

been in connection with the "palm oil process." By an inferior process, known as the "acid process," the plates, on coming from the rolling mill, are put in water tanks to prevent oxidation during the time that elapses before they are tinned. At the tinning house the plates are taken from the water and passed through a solution of muriatic acid and zinc—chloride of zinc—which floats on top of the molten tin in the tinning pot. This zinc solution causes a quick galvanic action, and as the plate is immersed in the tin the galvanic action causes the tin to adhere to the surface of the iron or steel plate. The plate is then passed through an oil bath. The process is cheap, and while the tinned plates are not so good or so durable as those tinned by the palm oil process, the fact of their being cheaper creates a large demand. Such plates, if used for roofing, frequently develop pin holes in the tin, due to a corrosive action set up by the acid, and this has led to much complaint about tin roofing—the fact being that in too many cases the cheaper and less durable plate has been used simply because of its cheapness, and with no regard to the service it will give. This is an unfortunate state of affairs that is evident

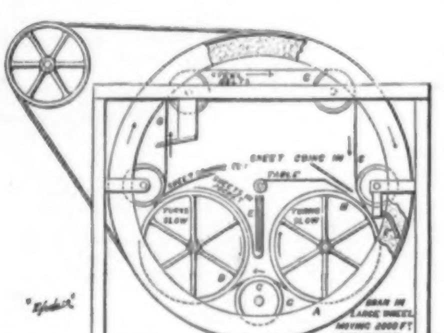
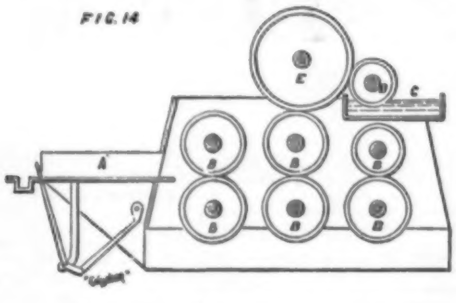


FIG. 13

in many other industries. A considerable demand has been for such plates as carry 3 lb. to 6 lb. of coating per box of I C plates, 14 in. by 20 in., 112 sheets; but even a heavy coating will not be durable if the metal upon which it is deposited is subject to corrosion under the coating.

One of the large manufacturers recently took out a series of patents on tinning machinery, covering operations briefly as follows: (1) A machine for drying and fluxing wet pickled black sheets preparatory to coating them with tin, as shown by the diagram, Fig. 14. The plates are fed to the drying and fluxing rolls from the table at A by an automatic feeding device, and pass between the rolls, B, which are heated. At C is a tank for the flux, in which runs the feed roller, D, which transfers the flux to one of the fluxing rollers, B, by means of the transfer roller, E. (2) A device for lifting, conveying and cooling the tinned plates operated in connection with the tinning pot and the rolls for conveying the plates therein. The device consists of two moving flexible carriers, having a space between them sufficient to give room for the plates, mounted on wheels or pulleys revolving in opposite directions and furnished with a series of opening and closing fingers for lifting, these fingers being operated by cams. (3) A tinning machine with the following series of operations: (a) Feeding the plates one by one automatically; (b) drying and fluxing the wet pickled plates; (c) tinning the plates and passing them between finishing rolls; (d) lifting, supporting and cooling the plates as they issue from the tinning machine; (e) cleaning the plates from oil; (f) polishing the plates. All these parts are connected by chutes and conveyors for automatically passing the plates along through the continuous series of operations. (4) An upright automatic lifter for raising the plates as they come from the tinning pot, so that they may cool while suspended in an upright position. Also a chute for delivering the plates automatically to the cleaning machine. (5) A pickling and washing plant having racks for holding and moving the

FIG. 14



plates in a body up and down in the pickling tank and washing tank, and a water-filled conveyor to carry the pickled and washed plates to the fluxing mechanism and protect them from oxidation, the conveyor being so constructed as to enable the plates to be sorted and the imperfect ones rejected as they are fed to the fluxing machine. The conveyor is a tank mounted on wheels and partially filled with water or other liquid to protect the surfaces of the plates from oxidation during their transfer. Rails are laid between the pickling and washing plant and the tinning plant, and the wheeled tanks, which may be used to store a supply of plates after washing, are moved over these rails on transfer trucks.

Tin plate scrap at the stamping works is a waste material, although several patents have been taken out for processes for recovering the tin from the iron or steel plate. It is used to some extent for sash weights, being melted and cast in the same way as iron weights, but the surface is very rough and these castings are not in much favor. As a general thing, the scrap is carted away loosely and used for filling in with dirt and other rubbish. To facilitate the removal and disposal of this scrap, several of the large stamping works are using the Champion baling press, which is specially built for compressing the loose and awkward scrap into compact blocks convenient for handling.

In conclusion I give a table—Table No. 7—showing the existing tin plate works of the United States, with the number of black plate mills and the number of tinning sets in each case, and showing also the various brands of plate manufactured by these works. The table represents the conditions at the beginning of April, 1895, and is taken from the Metal Worker; but I have made one or two corrections on the strength of personal information, and have also added an independent list of the black plate mills. Estimate No. 1 of the black plate mills is from figures furnished me in March, 1895, by the secretary of the American Tinned Plate Manufacturers' Association, and the three firms marked with an asterisk (*), namely, the Illinois Steel Company, the New Kensington Tin Plate Company and the Stickney Iron Company, are given by him only, and are not included in the list of the Metal Worker. The Illinois Steel Company's projected tin plate plant is considered very doubtful, but the other two plants are said to be already under construction. Estimate No. 2 of the black plate mills is the list given in the tabular statement of the Metal Worker. It is, of course, practically impossible to get such a published list absolutely complete and correct, as conditions are constantly changing during the time occupied by the compilation of returns and statistics. It is, therefore, of special interest to note the approximate correspondence of these two estimates, which were prepared independently. Whatever the actual figures may be, the figures here presented, considered in relation to the statistics and information already given in this report, must, I believe, be acknowledged to furnish conclusive evidence of the present importance and activity of the American tin plate industry and the probability of a much greater importance in the future.

In the editorial comment on the tin plate situation in the Engineer of February 1, 1895, it was stated that the policy of a present high price for tin plate and a subsequent abandonment of the industry has been advocated in Wales in consequence of the growing competition of the American industry, and this idea was rightly condemned. Many English industries have had to meet serious foreign competitions, but such conditions have been met by improvements to reduce cost of manufacture, and not by propositions to abandon the industry, even though some firms have been compelled to give up the fight. The Welsh manufacturers, however, have had a practical monopoly for so long, and the American competition has been of such recent and rapid development, that they have perhaps been bewildered by the sudden and successful attack upon their markets. There seems to be no reason at all for any such radical step as the abandonment of the industry. There is probably a field for all, but the manufacturers and men must grasp the situation and realize the fact that a new order of things must be instituted successfully to meet the changed conditions due to the disappearance of their monopoly of the trade.

MAGNETIC PROPERTIES OF BODIES AT DIFFERENT TEMPERATURES.

THE current number of the Journal de Physique contains the second part of the paper, by M. P. Curie, on the magnetic properties of bodies at different temperatures. The present paper deals with iron, nickel, and magnetite. In the case of iron, measurements have been made at temperatures between 20° C. and 1,360° C., and for field strength of from 25 to 1,350 C. G. S. units. The observations on nickel and magnetite were only made at temperatures above that at which the great change in the magnetic properties of these bodies takes place. The values obtained with iron up to about 756° C. agree with those previously obtained by Dr. Hopkinson. Above this temperature the author finds that the curves showing the relation between the intensity of magnetization (I) and the strength of the field are straight lines passing through the origin for temperatures between 750° and 1,280° F. decreases more and more slowly. At first (I) decreases to half its value for a rise of temperature of a few degrees, but between 950° and 1,280° the susceptibility is almost a constant, only decreasing very little as the temperature rises. At a temperature of about 1,280° the susceptibility suddenly increases by about 50 per cent., and then again gradually decreases up to 1,365°. The author, with some hesitation, gives the following explanation of this behavior: "Up to a temperature of 860° iron behaves like any other paramagnetic body. At a temperature of about 860°, however, it begins to change into a second allotropic form, this transformation being complete at about 920°, and the iron remaining in this condition up to 1,280°, and behaving like such a body as oxygen or palladium. Finally at 1,280° the iron changes suddenly back to its first condition."

The attractiveness of the above theory can only be appreciated by a study of the author's curves, for if the curve showing the connection between the logarithm of the susceptibility and the logarithm of the temperature is plotted, it is found that the curve between 750° and 860° would, if prolonged, form with the curve above 1,280° a curve in all respects similar to the curves obtained in the case of nickel and magnetite. With nickel the author finds that the temperature of the magnetic transformation is about 340°. After this temperature the susceptibility is independent of the strength of the field, and decreases regularly and very rapidly as the temperature rises. In the case of magnetite the chief magnetic transformation takes place at a temperature of 535°. At temperatures between 550° and 1,370° the susceptibility is independent of the strength of the field, and decreases regularly, and between 850° and 1,360° varies inversely as the absolute temperature. The value of K (see previous note, loc. cit.) being given by the expression $K = \frac{0.0280}{T}$ where T is the absolute temperature. From the differences exhibited by the behavior with change of temperature of diamagnetic and paramagnetic bodies, the author considers that these two properties must be attributed to different causes.—Nature.

DUCRETET & LEJEUNE'S POLE FINDER.

IN the various applications of electricity, it is often indispensable to know the direction of the currents that are passing through the different circuits to be examined. Manufacturers have already devised a large number of apparatus that permit of easily finding these different directions, but in many cases they have been unwieldy and but slightly practical, and have necessitated some manipulation. Messrs. Ducretet & Lejeune have recently devised a style of pole finder that we have had an opportunity of experimenting with for some time and which has been very useful to us. The apparatus is simple, very portable, and of very easy management.

The accompanying figures give a general view and the internal details of it. At the bottom of a box of small dimensions is arranged a helix, C, of insulated fine wire of a resistance of about 500 ohms. The extremities of this helix are connected with two strips of copper placed upon the side and that may be put in connection with the two conductors of the circuit to be studied. In the center there is a pivot, upon which rests a zinc disk, whose lower surface is provided with a movable astatic device formed of parallel magnetized bars having alternate poles, and the upper surface with a disk of Bristol board, upon which are marked the signs + and —. This disk, which, with its inscriptions, is shown in Fig. 3, is movable around the pivot upon which it rests. It is astatic and, consequently, proof against any terrestrial action. It can, moreover, be directed by means of a magnet, E, established in the prolongation of the box. Finally, above the disk there is a cover that is provided with two apertures, A and B, in which present themselves the signs + and — marked upon the Bristol board. If a current be made to pass into the wire helix, the field produced thereby will act upon the movable device and displace it in one direction or the other, according to the direction of the current, and the signs corresponding to such direction will be at once seen to appear. Let us add that a pedal fixes the movable device when the apparatus is at rest. A cover closes the finder, which can be easily put into the pocket.

In order to make use of the apparatus, it suffices to place it flat and to so direct it that at rest there shall be no indication in the apertures, A and B, in acting slightly upon the auxiliary magnet, E. Afterward each of the two conductors of the circuit to be examined is made to communicate with one of the strips of

DUCRETET & LEJEUNE'S POLE FINDER.

1. General view. 2. Interior view. 3. Movable device.

copper fixed to the side and that we have mentioned above. The circuit of fine wire will be immediately traversed by a current, and the movable disk be seen to displace itself in giving the marks + and — for the two conductors. This operation may be performed upon currents of feeble differences of potential (one volt, for example) as well as upon those of difference of potential of 110 volts employed in the distribution of electric energy. In both cases we have obtained satisfactory results. In installations in which it will not be possible to establish communications to the apparatus, the conductor may be placed near the finder, according to the line traced beneath the apertures, A and B, or the finder may be brought near to the circuit according to this latter direction. The same indications will again be given.

Upon the whole, the apparatus that we have described is, therefore, a very simple one and may prove of the greatest utility to electricians.—La Nature.

THE FIRST IMPORTANT TROLLEY DECISION.

THE recent decision of Judge Coxe sustaining one of the earlier Van Depoele trolley patents is the first rendered bearing on trolley mechanisms, and unless reversed may have important consequences. The parties behind the suit were the General Electric and Westinghouse Companies, the former as complainant through the Thomson-Houston Electric Company and the latter as defendant through the Elmira and Horseheads Railway Company. The patent at issue was granted to C. J. Van Depoele, April 1, 1890, on an original application filed March 12, 1887, and divided October 22, 1888. It contains no less than thirty-five claims, in reference to which the court says that the real invention is obscured in "a multitude of fuliginous and attenuated claims," and a seemingly needless verbosity, resulting in an indistinctness annoying to the public and "particularly to that part of the public which is called upon to construe the patent."

The court divides the patent into three parts: First, the contact device, commonly known as the "trolley;" second, the support therefor; and, third, the overhead switching devices.

The contact device is the usual trolley and is described as consisting of a grooved wheel mounted upon a pivoted support on the roof of the car, having a sufficient capacity of vertical and lateral automatic

adjustability and capable of being detached and lowered by an attendant on the car platform.

The support is a pole or arm mounted on the roof of the car and pivoted and swiveled so as to be capable of swinging both vertically and horizontally. Attached to the short arm of this pole is a weighted spring which operates to maintain normal contact between the grooved wheel and the suspended conductor. The overhead switching devices are placed at points on the line of road where branches and turnouts occur, and where the overhead trolley wires are required to branch correspondingly with the tracks. The object is to transfer the trolley from the main wire to the branch wire, and vice versa, without interrupting the contact.

The switching device, as shown in the patent, consists of a Y-shaped plate of sheet metal with depending side flanges. This plate is secured to the under side of the trolley wire at the point where it branches, the narrow end being turned in the direction of the main wire and the other end being connected with both the main and branch wires. The narrow end is wide enough to permit of the easy movement of the trolley wheel through it, while the other end is wide enough to permit the wheel to move out in the direction of either the main or the branch wire. The switch device is placed at the junction of the main and branch wire above the corresponding switch on the track, and the wheel is to be so supported on the roof of the car that it will not reach the switch box until at least the forward wheels of the car have planted the crude and tentative prior structures and have continued in use until the present time. No one can read this record without being impressed with the truth of this proposition, and this being so, the court naturally approaches this controversy in liberal spirit and with an inclination to give the inventor the full fruits of his invention."

The court then takes up the case and refers to the patent as covering devices and combinations by which electric cars are run automatically upon branches and turnouts, the motor being supplied from an overhead system of wires by an under-running trolley pressed up against the wire by a spring or equivalent device, and automatically adjustable to the wire. The other important device in the patent is described as an overhead switch so mounted on the wire that when the forward wheels of the car take the track switch a trend or direction is given to the trolley, so that, when it reaches the overhead switch, it is guided to the proper branch automatically without in any manner disturbing the electric current or the running of the car.

In this way, the court considers, a system is produced which is well nigh perfect in its essential details, and in order to attain this result Judge Coxe believes the record proves that many difficulties had to be surmounted and many problems solved.

The court decides against the contention of the defendant, that the patent in suit is void because it is covered by earlier patents granted to Van Depoele. Referring to a patent cited, dated February 5, 1889, defendant never acquired any right from the Sprague Company, for that company had none to give. If the complainant had in any manner induced the defendant to purchase the cars in question, intimating that they did not infringe the Van Depoele patent, the situation would be different, but as it is, the case seems devoid of every element of estoppel.

The court finds that two claims relating to the construction and attachment of the conductor switch were infringed; also that two claims relating to the directive action of the track switch are infringed; and that one claim relating to the centralizing spring is infringed by one type of trolley in use and not by another type employed.

Pending an appeal to the United States Circuit Court of Appeals, no accounting is ordered, and the injunction against the Elmira road is suspended.—Electrical World.

INDUSTRIOUS DOGS.

IN connection with the International Dog Show which was held in Dresden from May 21 to May 24, under the patronage of the King of Saxony, there was an exhibit of draught dogs, harnesses for the same, and models, etc., intended for the instruction of the owners of these dogs. The Department of the Interior considered this part of the exhibition of great importance, and, therefore, offered special prizes, consisting of State medals and of money; and the

DRAUGHT DOGS AT THE INTERNATIONAL DOG SHOW, DRESDEN.—DRAWING BY ALBERT RICHTER, FOR THE ILLUSTRIRTE ZEITUNG.

passed the junction of the main and branch tracks. Thus, the switch box will guide the wheel automatically upon that one of the trolley wires which corresponds with the track upon which the car has been directed.

Judge Coxe opens his opinion with a dissertation on electric traction. "Electricity," he says, "has so completely supplanted horse power as a means for propelling street cars that it is difficult to realize that only about ten years have passed since the first successful electric railway was installed. At the present time there are more than 500 roads in operation, employing an immense army of workmen and a vast amount of capital. That this wonderful result was accomplished only after innumerable difficulties and obstacles had been encountered and overcome is manifest. The potentialities of the art attracted a large number of brilliant and ingenious men, who for more than a decade have been laboring to make electric railroading successful. Even after the necessities of the situation had evolved the fundamental principle of taking the electricity from an overhead conductor, the difficulties in finding suitable contact and switching devices for a long time prevented commercial success, and the solution of the problem taxed the ingenuity of a large number of inventors."

He next gives a personal estimate of Van Depoele, as follows: "Although the electric road of to-day is a composite organism to which many ingenious and able men have contributed, yet it cannot be denied that to Van Depoele, more than to any other man, belongs the credit of having made it a practical working success. His contributions to the art rapidly sup- for which an application was filed November 12, 1888, subsequently to the filing of the application of the patent in suit, the court says that it is manifested, on reading the earlier patent, that it was intended to secure a few minor improvements upon the broad invention then pending in the Patent Office. The claims of the earlier patent are declared to be wholly insufficient to secure the invention of the patent in suit, as an infringer, unless he used the peculiar contractions and guide rims shown in the former, would escape all accountability if the latter is held invalid.

The next point taken up is the claim of the defendants that there is no invention in the claims relating to the switching apparatus, because the patentee has simply suspended face downward the well known form of railway switch. The court holds that, assuming this to be a fair statement of the Van Depoele achievement, it does not follow that patentability is wanting. When it is considered, it is added, that he was dealing with an under-running system, that it was necessary to shift not only the trolley but the "mysterious current" which the trolley carries, and that he accomplished this result automatically when others failed, it is not difficult to place him above the plane of the mechanic.

The argument of estoppel is next considered. It is based upon the fact that the Sprague Company, from which six cars were purchased in 1890, was absorbed by the General Electric Company in 1892, and that, therefore, the latter by acting as complainant is violating its obligation to the defendant as purchaser from the Sprague Company. The court decides that the

Dresden Society for the Protection of Animals also offered prizes of money and diplomas. Systematic breeding of dogs of this class is rare, partly because of a lack of purchasers who can pay well, the poor people who use them often putting the work upon dogs that are unfitted for it, and using harnesses that are not suitable. According to official statistics in 1894, there were 671 draught dogs in Dresden, 685 in Leipzig and 310 in Chemnitz. The number of such dogs passing between Leipzig and its suburbs is reckoned as one thousand. From 175,000 to 200,000 vehicles drawn by dogs pass each year over the Augustus and Albert Bridge, where toll is taken—that is from 380 to 400 each working day—about one-tenth of which are drawn by two dogs.

The prizes were given for single as well as double teams, and in awarding them both the animals and the harnesses were considered. In taking a record of each dog, the character and color of his coat and all peculiar marks were noted. Also the weight of the wagon, and the style of harness, whether with a collar or straps. Each single dog was brought forward harnessed to an empty wagon and driven by an adult, and it was required that each dog should be provided with a properly fitting muzzle, not connected with the collar or harness. Dogs that were lame or sick (this included skin diseases), those under one year of age or with imperfect teeth, and dogs that were pregnant or had young pups, could not compete for the prizes. The rules of the exhibition required that the dogs should measure at least one foot seven inches from the fore feet to the withers, that the vehicles

and harnesses should be in good condition, and that the latter should fit the dogs.

Thirty-nine teams, some driven by men and some by women, competed for the prizes, and three State medals, three money prizes, and eight diplomas were given, the latter having been offered by the Dresden Society for the Protection of Animals. Premiums were also given for a collection of apparatus for the protection of animals, and models of dog wagons, harnesses, etc., exhibited by the Leipzig Society for the Protection of Animals; and for a series of instructions and directions for owners of draught dogs, written by Secretary General Gustav Schafer, of Dresden.

It is hoped that this first exhibition of draught dogs will incite the people to hunt up proper material and breed good dogs for this purpose, and to create a standard for harnesses. In Belgium, Holland, and also in France and England, but particularly in the first-named country, special dogs are already being raised for draught purposes, and the Leipzig Society for the Protection of Animals has raised some such dogs, which it has given gratis to the poor.—Illustrirte Zeitung.

THE DOG MOTOR.

Mr. Richard, of Paris, has invented a very neat, practical and useful motor, which was exhibited at the Agricultural Exhibition and at the Exhibition of Sciences Applied to Industries. The annexed cuts—for which we are indebted to La Nature—give a very good illustration of this novel motor, which was in successful use several years ago, but whether it is now employed we are unable to say, nor have we the maker's address.

The animal, in this case a dog, is placed in a box or crib resting upon a shaft supporting the entire upper part of the machine. In Fig. 1, the animal is represented at rest, and the weight of the animal, maintaining its center of gravity, does not act upon the main driving wheel. But as soon as the box is in the position indicated by dotted lines in Fig. 2, that is, as soon as the tangent forms an acute angle with the vertical, the weight of the animal is sufficient to turn the wheel in the direction indicated by the arrows. The animal will naturally try to advance up the inclined surface, and will rotate the wheel by this action, as its weight continually acts upon the wheel. A fixed platform, E, is arranged below at the side of the endless belt as a resting place for the animal, and a cup containing water is arranged in front of the box, so that the animal can drink while resting.

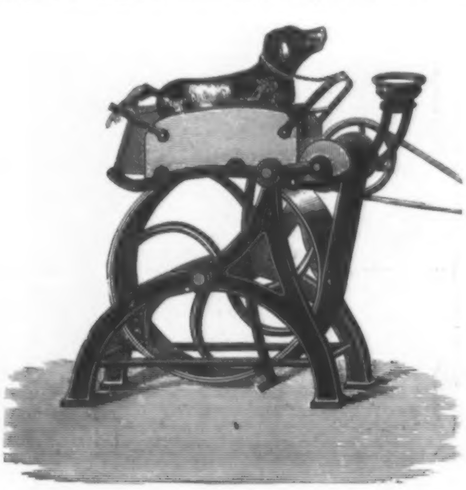


Fig. 1.

Fig. 2.

THE DOG MOTOR.

THE POST OFFICE—SECOND-CLASS MATTER.*

The feature of finance in the early days of our postal system vexed the officials the same as it does now. In that time, however, the idea of a business post office prevailed, and it was expected it would be so managed as to pay the government a profit.

In 1753 when Franklin was first appointed Postmaster General, he and his assistants were to have for their labor 600 pounds per year, provided they could make it out of the profits of the business. No deficits were allowed, you see.

Until 1851 the department was self-sustaining, indeed, a part of the time a small profit was derived. The succeeding 30 years, during which time the country was rapidly developing, each and every year showed a deficit—the lavish expenditures and bad management that prevailed from 1856 to 1860 in postal affairs brought about a deficit of more than ten and one-half millions in the year 1860, notwithstanding the gross revenues of that year were $8,516,067.

In 1875 the revenues had increased to $26,771,218, and in 1884 to $43,338,127.

The act of Congress establishing what is known as second-class matter, or more properly, to enable publishers to mail newspapers and periodicals at the pound rate, passed June 23, 1875, the rate being two cents per pound. This was modified in 1885 so as to make the rate one cent per pound. This act of Congress was intended to give the people the benefit of cheap rates of postage on newspapers and periodicals, because then, as now, the newspaper was recognized as the great educator. The government argued that educated citizens made better citizens than were the uneducated, and favored the rate of two cents per pound. The abuse, however, of this liberal and just law is giving the postal authorities much anxiety, since every dollar of the deficiency can be traced directly to this service. Indeed, the loss to the government the last fiscal year by reason of the privileges conferred by this act is about $16,000,000.

It is stated there are now entered at the second-class rates of postage publications of all kinds numbering 41,717. The Hon. Third Assistant Postmaster General says, in his report for the year ended June 30, 1894, favorable action was taken on 6,003 applications for the entry of newspapers and periodicals as second-class matter, of which 4,604 were new applications, while 1,399 were old ones seeking re entry, and that applications were denied 603 cases. The Hon. Postmaster General ably discusses the several phases of second-class matter in his last annual report, which commends itself to the careful consideration of every publisher. I quote from his report that you may see the loss sustained as claimed by him.

He says:

"I have examined to some extent the statistics of second-class mail business of past years, including its cost in comparison with the business of to-day, and am convinced the statutes and precedents upon which the business now rests are defective, that they embody the only really great abuse at present existing in the postal service, and that as this abuse is growing all the time, some remedy should be applied."

The weight of second-class matter in 1888 was 143,000,000 pounds, and in 1894, adding the free county, was nearly 300,000,000 pounds, or about two-thirds of the gross weight of matter of all classes carried in the mails. The total weight of all matter dispatched in the mails of the United States during the year ended June 30, 1894, was 451,000,000 pounds, of which 299,000,000 pounds, or nearly two-thirds, were comprehended in the mailing of second-class matter.

The cost of transporting this matter was $36,207,572, which gives an average of about eight cents a pound. After deducting free county and giving all possible credit, shows a net loss to the government on the transportation of second-class matter of $16,973,000. Such a condition cannot be found to exist in the postal administration of any other nation.

From the best information I am able to obtain, I believe our people exact and receive more accurate and speedier service, taking the whole country together, than is exacted or accorded the patrons of any other postal establishment, and including the pneumatic tube and postal telegraph, with which we are not yet equipped, we render a more accurate and speedier service in our cities than is rendered in the great cities of Europe, especially so since their population does not, as does ours, move their business places and homes the first of each May and many more frequently during the year.

That you may have an idea of the vastness of our postal service, I give you an average day's work as performed throughout the country:

Number of miles of post route run	1,100,000
" stamps manufactured	8,300,000
" envelopes "	1,800,000
" postal cards "	1,500,000
" pieces mailed	15,700,000
" letters "	7,400,000
" pieces of mail matter distributed and redistributed by railway postal clerks	27,500,000
" pieces of mail handled in Dead Letter Office	24,000
Daily transactions in money orders	$1,100,000
Daily expenses	$231,100
Second-class matter about	400 tons

Our 20th century post office—will it show within the next 100 years an equal number of improvements to those that have been developed within the past 100 years? My answer is yes.

Electricity will be the motive power of that century. Space will be to a greater extent in the future than in the past eliminated from the problem of rapid transit and New York will be distant from Chicago less than half the time now required by our quickest trains. Within that century the problem of aerial navigation will have been solved and again will time and space be almost annihilated and the eight days usually figured as quick time between Chicago and London will be lessened more than half, and Chicago will have become the great clearing house of all the world. Our post office of that time must perforce be equipped with all the best appliances for the rapid and accurate handling of the mails that will be available in that electrical age. Its employes must be as well equipped to distribute mail for immediate delivery in all the countries of the world as they now are to handle that for the United States.

We now have electrical machines capable of canceling the stamps on and of postmarking 40,000 letters per hour. In that time it will be necessary to have machines that will postmark 100,000 letters per hour. The stamps will not require canceling, because some device will be discovered whereby the act of affixing the stamp will cancel it, or else the government will furnish all envelopes and wrappers at only the face value of the stamp, in which event it will be a matter of no moment whether the stamp is canceled or not.

Your letter carrier of that day will be a mechanical electrical device, and all letters of special import will bear an immediate delivery mark and be delivered at your place of business or residence as often and at such hours as you may direct.

* Extracts from an address delivered by John A. Montgomery, superintendent of the Chicago mails, before the Chicago Trade Press Association.

THE INFLUENCE OF THE LOCOMOTIVE.

The Railway Congress brings home to us the immense influence that the locomotive has exercised upon the fabric of society. It is scarcely possible for us of the present day to realize civilization apart from railways. If we try to imagine our condition with no means of progression on land except that depending on the muscular energy of ourselves or of horses, we find nearly every avenue of thought blocked at the outset. The regular supply of food and coal, in the quantities we are accustomed to, would be impossible, and very many of the existing channels for our energy would be closed. It seems as if we must revert to something very like barbarism. That idea is, of course, greatly due to our want of imagination. It is only during the past seventy years that the locomotive has had any real existence, and it is a very insignificant part of the history of the world that can be compressed into that period. Of what happened in the thousands of years preceding the nineteenth century we are very ignorant, but we know that numerous civilizations arose, flourished, and decayed. Possibly there were others of which we know absolutely nothing. Enough, however, remains to show that vast cities existed, in which people led busy and probably fairly happy lives; there were governments so highly organized that they administered law over areas as large as any that now own a single sway; art, poetry, literature, and the drama attained heights far beyond our modern reach, and in many ways man was able to lead a full and intellectual existence without the aid of rapid transport.

Nevertheless, the fact remains that if the railway were suddenly abolished, suffering and disaster of inconceivable magnitude would fall upon us, and until we had so changed our habits as to bring them into harmony with the altered state of affairs, the greater part of us would have to face cold, starvation, and death, particularly those beyond the reach of sea carriage. The locomotive, next to the ocean steamer, is the greatest labor-saving appliance ever invented, and if it were no longer available, much that it now performs would have to be effected by muscular force. But there would be no new source from which to pay for the labor thus required; indeed, the available fund would be reduced by the withdrawal of men from other industries. The population of the country would have to make shift with a lessened amount of food, clothing, luxuries, and amusements. The poor would find their tables provided with coarser viands; meat would give place to bread, bread to oatmeal, and oatmeal to potatoes, almost the bottom step in the dietary of poverty, if we exclude the boiled nettles of the French peasant, during the years preceding the revolution. The rich, too, would have to economize, except in the case of those over-fortunate individuals that now have more money than they can conveniently spend. Wealth, however, is not the product only of the railway age. Money was spent in Rome in a way undreamed of even in Paris under the empire. There were feasts there that would have made Bignon sigh with envy when he thought of the bill. But such expenditure was confined to the few—to a minority so small as to be inappreciable in figures, although it made a great show in society. And it must be remembered that, although Rome had no railways, it had splendid means of communication with the choicest parts of the world. It could command all the products of the Mediterranean littoral, from Egypt to Spain, at a less cost of carriage than must now be paid by an inland town. Further, it did not need to balance its imports by exports. A great portion of them came as tribute from conquered nations. We very much doubt if in any portion of the world's history great wealth has been amassed in any place badly provided with means of transit.

Before the advent of the locomotive all great towns and cities, in Europe at least, were built on the banks of important rivers or were near the sea. Their existence depended on their being able to obtain their stores of necessaries by some more certain and economical means than road carriage. Even then, it is to be feared, the bulk of their inhabitants fared very badly according to our modern ideas. We know that the Roman proletariat cried for panem et circenses, and that the ruler who could provide a plentiful store of corn from Egypt had little to fear from social disturbances. In the present day wheat satisfies but a very small part of the wants of the average man. The railway has so enlarged his desires that a restriction to bread and water is considered a punishment even in prison. In China we have the opportunity of studying the condition of a people without labor saving appliances. We see a frugal, hardworking, and, in some senses, highly civilized population situated in a fairly fruitful country, and yet bowed down between the twin evils of overwork and starvation. It is only by nine-tenths of them living upon food that the English workingman would consider barely fit for pigs that they are able to exist, and this in spite of the fact that when Chinamen are planted among whites, they rapidly acquire a comfortable position by displacing the less competent members of the superior race.

There is, undoubtedly, a general tendency among mankind to congregate in towns and cities, but during the greater part of the Christian era circumstances have prevented this disposition having much play, except in favored positions. When the cost of carriage is very great, and when labor gains but little from mechanical aid, both the man who tills the soil and he that eats its fruit must live near together, and so communities, if they exist at all, cannot be great. Manufacturers naturally form colonies, the size of which depends on the value of their goods as compared with

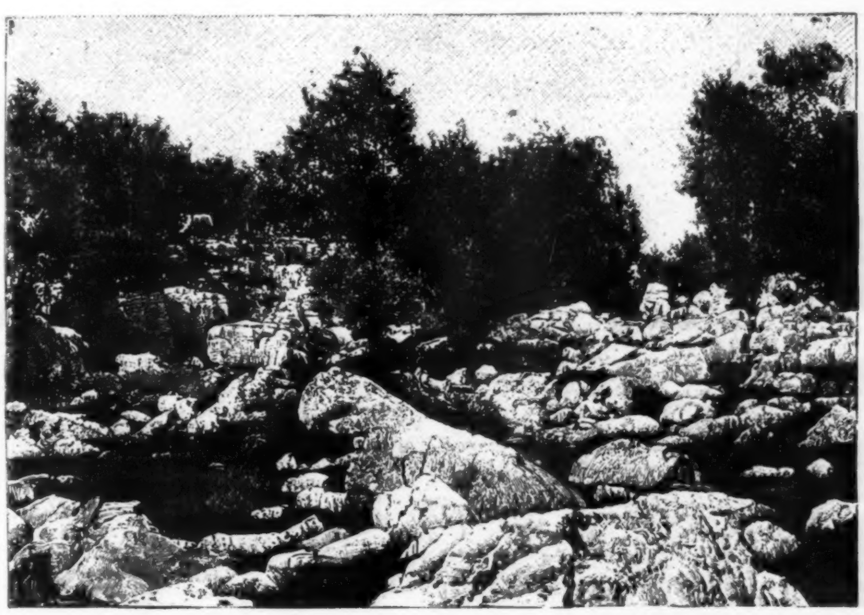
their bulk and the cost of transit. Within the past few years we have seen great iron and steel works moved from the Midlands and transported to the coast. The railways, in spite of all the advantages they offered, strangled them with their charges, and it was only under the cheaper conditions of ocean transit that they could live. When the prices of cotton goods fell, Manchester found the cost of 36 miles of railway carriage to and from Liverpool so intolerable that it spent millions on a ship canal. From the same city the historical works of Sharp, Stewart & Co. were removed to Glasgow in search of better economic conditions, among which reduction of carriage expenses was a most important item. Hence we see that not only formerly, but also to-day, people who have to earn their living must live—not where they would choose—but where they can thrive the most. Hence we understand how it was that towns grew so slowly until the railway arose to alter our social conditions.

Modern cities are absolutely dependent on the locomotive for their existence from week to week, and it really seems as if some of them were so large that they could not be fed by any other means. Formerly cattle were driven to London, to be there slaughtered, but one shrinks from picturing the state of our roads if that practice still prevailed. Of course our highways have long since ceased to grow. As the town stretches outward into the country, streets multiply, but main avenues remain much as they were at the beginning of the century. The railways carry the increased traffic, and if they were abolished, the first thing to be done would be to build roads to replace them. But even were all done that is possible to replace the railroad and the locomotive, the removal from other industries of the large amount of labor required for transportation, and the immense rise in price of all heavy or bulky materials, would, as we have pointed out, so transform our social conditions that we should have to give up the greater part of what we regard as the pleasant side of life. One does not need to be very old to notice the great change that has come over the habits of the middle and the lower middle classes. What fifty years ago were luxuries are now necessities, while the necessities of those days are regarded as only endurable under the stress of the direst poverty. If we search the very meager accounts the historians provide of the manners of the middle ages, we encounter a picture of dirt and discomfort which is absolutely revolting to us. The alteration from the former state of things to the present is almost entirely due to the locomotive and the railway, particularly in northern climes. In southern Europe and in sub-tropical regions life is easier. Clothing and shelter are only required in a very moderate degree, while the soil gives its harvest without much labor on the part of the husbandman. It was under these favorable conditions that the ancient civilizations were reared, aided almost always by successful conquest, and the enforced labor of captive races.

The steam railway is, as we have said, the greatest labor-saving machine that the world has ever seen. If it were only that, it would still excite our admiration, and its inventors and builders would deserve our gratitude. But its effects in the moral and intellectual world probably exceed those in material affairs. Just as people bred in a city differ from their cousins of the country, so do the inhabitants of a developed land stand out in comparison with one that still depends on the wagon and the stage coach for its transport. To find on one's breakfast table the replies to letters addressed only twenty-four hours previously to correspondents 400 miles away; to be able to enjoy the exhilaration of tearing through the country at the rate of 40 or 50 miles an hour; to be able to travel from London to Vienna in less than two days; all these are mental stimuli that infallibly show their effect on a population, and cause it to live at a higher rate—to take more out of time—than is possible when one must either remain in one spot or spend a good part of life in getting from place to place. Time is money to most of us, and it is only a small part that we can spend as we please. The major portion is mortgaged beforehand for food and clothing. What we can get out of the remainder in the way of knowledge, experience, and widened views of the world and man depends very much on the facilities we have for locomotion. Not only have we the benefit of what we gather ourselves in this way, but we also share in the gleanings of others. The most characteristic feature of the nineteenth century is the rapid increase of knowledge and its immediate dissemination. The increase in labor-saving devices has set at liberty great numbers of men who are able to devote themselves to intellectual pursuits, and to place on record the results of their researches. Their writings, instead of passing slowly and fitfully through a small circle of readers, flash over the world and are accessible to all. We remember once reviewing a book in which the author ascribed the theory of evolution to the express train, because, he argued, without our modern system of railways it would have been impossible to gather together the immense mass of facts necessary to justify the hypothesis. Possibly he was correct; certainly the man of science is as deeply indebted to the railway as is the engine driver, who, but for the locomotive, would have had to gain his living by carrying heavy burdens on his shoulders, instead of merely watching a steam motor do his work for him.

In concluding, it is sad to have to confess that while the railway has given to the bulk of us easier lives and more time for intellectual enjoyment, we have not been able to overtop the mental stature of those that went before us. We suppose that there are now in this country a hundred poets and dramatists for every one in the time of Elizabeth, but how much more worth are the writings of the few than of the many! Our artists, again, have the run of all the galleries of Europe, and can compare the styles of all ages, but still the old masters, who often lived and died within the bounds of a petty Italian state, are beyond their rivalry. Our architecture, alas! is worse than our art. In all these things we must confess our inferiority. Even in science, which is our strong point, Newton, Kepler, and Copernicus stand head and shoulders above us. Great men cannot be made by machinery, and, indeed, it seems as if our modern system were antagonistic to their growth. The average man gains immensely by having a vast amount of information placed at his command, and by being able to enter any field of research that attracts him, but the genius seems to suffer. His relative mental stature is, of course, depreciated by the presence of a crowd of fairly big men among whom he is placed, while his actual size does not come up to that of the giants of the past.

In all professions we find it admitted that the places of the great men of the early part of the century are not filled again. The average knowledge and ability of the members is immensely raised, and capable men can be counted in dozens where once they were to be enumerated in twos and threes. But it is seldom that we find any that stand apart from their class, on a distinct plane, as was once the case. Our modern improved methods, according to which knowledge is treated as a raw material by mechanical methods, and is then administered like physic, is enormously successful up to a certain point. But beyond that point, the influences which are typically represented by the locomotive tend to repression. The role of machinery is to duplicate existing objects; creation is beyond its scope.—Engineering.



ROCK IN THE FORM OF A TIGER, SITUATED IN THE WOODS OF PAIOLIVE.

ROCK SIMULATING A TIGER.

THE photograph reproduced herewith was taken in the woods of Paiolive (Ardèche.) It represents a rock in the form of a tiger lying upon its belly with the forelegs extended. It is in the midst of a locality in which rocks abound, which contains many curious things, and which is but little visited.—La Nature.

PREPARATION AND PROPERTIES OF PURE MELTED MOLYBDENUM.

By HENRI MOISSAN.

IN a former paper we have shown that it is easy to produce cast molybdenum, by heating in the electric furnace a mixture of charcoal and of the oxides of this metal. We shall now give the continuation of our researches on this question.

We must first mention that molybdenum, which is obtained in a pulverulent state by the reduction of the binoxide in hydrogen, was fused by Debray before the blowpipe only in the form of small globules containing 4 to 5 per cent. of carbon.

To prepare molybdenum we set out from pure ammonium molybdate, reduced to powder and placed in a crucible of refractory earth, No. 12, capable of containing 1 kilo. The crucible, covered with its lid, is heated for one and a half hours in a Perrot furnace. After cooling, the oxide is a dense powder of a violet gray, corresponding to the formula MoO_2. One heating yields from 760 to 770 grammes of oxide. This oxide was mixed with sugar charcoal, in powder, in the following proportions:

Oxide	800 grammes.
Charcoal	80 grammes.

In this mixture the oxide is in decided excess compared with the charcoal. The powder is heaped up in a crucible of coke and submitted to the action of an arc produced by a current of 800 amperes and 60 volts for six minutes. We must avoid the complete fusion of the metal, so as to leave a solid layer in contact with the crucible which would be strongly attacked by the liquid molybdenum. Under these conditions we obtain a metal perfectly pure and free from carbon; it is easy in one hour to prepare more than 1 kilo.

If this preparation lasts more than six minutes, the molybdenum obtained is liquefied, corrodes the crucible, becomes carbureted, and we obtain a gray cast metal, very hard and brittle.

CAST MOLYBDENUM.

This cast metal has a specific gravity of 8·6 to 8·9, according to its proportion of carbon. When saturated with carbon it is much more fusible than molybdenum. When rich in carbon it is gray and brittle; at 12·5 per cent. of carbon it becomes white, and can be broken up upon the anvil only with difficulty. It presents all the characteristics of the molybdenum studied by Debray. It rapidly dissolves carbon, and abandons it on cooling in the state of graphite, precisely as does cast iron. Nevertheless, when saturated with carbon it yields a carbide, crystallized in fine needles. Gray cast molybdenum is very hard; it scratches steel and quartz. When melted, it becomes a very mobile liquid, which can be poured while giving bright sparks and abundant fumes of molybdic acid. We have been able to melt and cast ingots of from 8 to 10 kilos. These castings had the following compositions:

	White.	Gray.
Molybdenum	95·83	92·46
Combined carbon	3·04, 3·19, 2·54	4·90, 5·50
Graphite	0·00	0·00, 1·71
Slags	0·74, 0·53, 0·62	— —

MOLYBDENUM CARBIDE.

This compound is prepared by heating in the electric furnace molybdenum binoxide with an excess of charcoal. The best proportions are: Binoxide, 250 grammes; charcoal, 50 grammes. The duration of the heating is from eight to ten minutes with a current of 800 amperes and 50 volts. If we use an excess of charcoal, it is found in the mass in the state of graphite.

The regulus obtained is of brilliant white and has a crystalline fracture; it splits readily. It is readily crushed on the anvil, and we may separate from it small elongated prisms of a distinct crystallization. Its specific gravity is 8·9, and its composition is Mo_2C.

ANALYSIS.

In the various specimens described in this memoir, the molybdenum, after treatment with nitric acid, has been precipitated as mercurous molybdate, and finally determined as bioxide. When the carbide contains no graphite, the carbon was separated by pure dry chlorine, and then determined by combustion in oxygen, according to the weight of carbonic acid collected. According to this method, the portions of carbon are always rather low.

We have obtained the following figures:

				Theory for Mo_2C.
Molybdenum	93·82	—	—	94·12
Combined carbon	5·62	5·53	5·48	5·88
Graphite	—	—	—	—
Slags	0·17			
	99·61			

If the carbide contains graphite, it is attacked in a flat bottomed flask traversed by a current of oxygen. The gases evolved pass into a tube filled with copper oxide, the watery vapor is retained in a tube filled with sulphated pumice, and the carbonic acid is fixed in potassa. The increase of the weight of the potassa tube shows the carbonic acid, and consequently the carbon. The acid liquid of the flask, after filtration and washing, shows the graphite, and the molybdenum is next determined by mercurous nitrate. This novel method gave as results:

	9.	10.
Molybdenum	92·60	91·90
Combined carbon	5·15	5·43
Graphite	1·61	1·98

On taking account of the graphite and calculating the proportion of molybdenum to the carbon we find:

	9.	10.	Theory Mo_2C.
Molybdenum	94·45	94·10	94·12
Combined carbon	5·55	5·90	5·88

PURE FUSED MOLYBDENUM.

Pure molybdenum has a specific gravity of 9·01. It is a metal as malleable as iron. It can be easily filed and polished, and forged hot. It does not scratch either quartz or glass. When free from carbon and silicon, it scarcely oxidizes in the air below a dull redness. It may be kept for several days unchanged in water, whether ordinary or charged with carbonic acid. In presence of air below dull redness it is covered with an iridescent film, as is steel. About 600° it begins to be oxidized, and yields molybdic acid, which is slowly volatilized.

A fragment of molybdenum heated for some hours in a sloping porcelain tube over an analytical furnace yields, in the upper part of the tube, a felted mass of crystals of molybdic acid. The metal is not covered with any other oxide, and finally disappears, leaving a fine crystallization of molybdic acid. If heated before the gas blowpipe, a fragment of molybdenum emits vapors in considerable quantity. If heated before the

oxyhydrogen blowpipe, it burns without melting, giving off abundant fumes of molybdic acid and leaving a blue oxide, sparingly fusible. If heated in a current of pure oxygen, it takes fire between 500° and 600°; and if the current is rapid, the combustion may continue without the intervention of any extraneous source of heat.

This combustion ensues with intense incandescence, and may serve as a fine lecture experiment.

Melting potassium chlorate attacks molybdenum with violence. The chlorate is melted, and a fragment of molybdenum thrown upon its sufrace, when it becomes incandescent and revolves upon the surface of the liquid.

The temperature of the reaction rises rapidly, the molybdenum burns with flame, and there escape abundant white fumes of molybdic acid, which remain suspended in the air in the form of white floating filaments. Sometimes the fragment of molybdenum is raised to a temperature high enough to perforate the side of the capsule, which is melted in contact with the metal.

Melting potassium nitrate under similar conditions yields a reaction similar, though less violent, with formation of an alkaline molybdate.

A mixture of molybdenum and lead peroxide heated in a test tube produces a great liberation of heat and light.

Sulphur has no action at 440°, but hydrogen sulphide at 1,200° transforms molybdenum into a bluish gray sulphide, amorphous, having the properties of molybdenite, and leaving, on friction, a black mark upon paper.

Fluorine does not attack molybdenum in fragments, but if the metal is coarsely powdered, there is formed, without incandescence, a volatile fluoride.

Chlorine attacks molybdenum at dull redness, but without incandescence. With bromine the action takes place at a cherry red heat, but without great intensity.

Iodine has no action at the temperature of softening glass.

Silver, zinc and lead fluorides are decomposed, but without the formation of volatile fluorides.

Phosphorus perchloride, if slightly heated, readily attacks molybdenum, forming a volatile chloride, which is easily modified in presence of atmospheric moisture, taking a fine blue coloration.

This reaction is produced with most of the compounds of metallic molybdenum—the oxides, the sulphide, molybdic acid, and the molybdates. It may serve for the rapid detection of metallic molybdenum or its compounds. It is effected in the following manner:

Into a small test tube we put a fragment of the substance in question, adding a little phosphorus perchloride, and heating gently. There are formed reddish fumes of molybdenum chloride and oxychloride, which condense in a brown ring more or less intense. If the quantity of molybdenum is very slight, the ring may be scarcely visible. It will then be sufficient to expose it to moisture to see it take an intense blue tint, due to the formation of hydrated chloride.

The action of hydracids upon pure molybdenum is almost similar to that which they exert upon cast molybdenum. These experiments, however, have been described by different observers, Bucholz, Berzelius and Debray. We merely mention that hydrofluoric acid does not attack it, but on adding a drop of nitric acid the action sets in and continues with energy. In presence of a mixture of equal parts of the two acids the solution is complete, and there remains a rose colored liquid which, with ferrocyanide, gives an intense red brown color, but no precipitate. The mass some hours afterward coagulates to a jelly.

In a current of nitrogen at 1,200° molybdenum, whether in fragments or in powder, does not form a nitride.

It does not combine with phosphorus at the temperature of melting glass.

Boron combines with molybdenum at the temperature of the electric furnace, yielding an iron gray melted mass containing cavities lined with prismatic needles.

Under the same conditions, silicon yields a crystalline silicide not fusible before the oxyhydrogen blowpipe.

The action of carbon deserves to arrest our attention for a few moments.

Pure molybdenum, as above described, is a soft metal, which is easily filed and which does not even scratch glass. If we heat a fragment of molybdenum for some hours to a temperature close on 1,500° in the midst of a mass of charcoal in powder, it becomes cemented, takes up a small quantity of carbon, and its hardness increases so that it can scratch glass. If we then heat it to 300° and plunge it suddenly into cold water, it is tempered, becomes brittle, and hard enough to scratch rock crystal.

Inversely, if we take cast molybdenum containing 4 per cent. of carbon, very hard and brittle, and heat a fragment for some hours with molybdenum binoxide in a lined crucible, it becomes refined, and its surface may then be readily filed and polished.

I attribute this decarburation of the solid cast molybdenum at a temperature very remote from its melting point to the ready diffusion of vapors of molybdic acid through the metal. I consider that these properties may find applications in metallurgy.

If, in a metal saturated with oxygen, such as is obtained in the first period in the Bessemer converter, we wish to remove this oxygen, we add manganese, which is oxidized more easily than iron, and then passes into the slag (Troost and Hautefeuille). It has been also proposed to employ aluminum, which has given good results, because it is combustible, i. e., because it seizes on the oxygen, but which has the inconvenience of producing solid alumina. I think that molybdenum may be used under the same conditions; it would have the advantage:

1. Of yielding a volatile oxide, molybdic acid, which would be liberated immediately in the gaseous state, stirring up the whole mass.

2. Used in a slight excess it would leave in the bath a metal as malleable as iron, and capable of being tempered along with the latter.

The powder of molybdenum, which it has been attempted to use already, cannot render the same services, because it burns rapidly upon the surface of the bath in contact with the air without having yielded any useful effect.

ANALYSIS OF PURE MOLYBDENUM.

	11.	12.	13.	14.
Molybdenum....	99·98	99·37	99·89	99·78
Carbon..........	0·00	0 01	0·00	0·00
Slag	0·13	0·28	0·08	0·17

Comptes Rendus, cxx, p. 1320; Chem. News.

[Continued from Supplement, No. 1022, page 16341.]

THE USE OF HOT AIR IN DRYING.*

By E. M. Cook, New York.

The methods of handling textile fabrics, etc., are comparatively simple, and are so well known that it is scarcely necessary to refer to them. Goods in considerable pieces may be stretched from side to side, or up and down, in a drying chamber, in some cases moving automatically, the drying currents having access to them; or they may be passed over revolving heated surfaces, as in the well-known form of paper machine. In handling materials in lumps, grains, or powder, the problem is more difficult, and, apart from revolving cylinders or fixed cylinders with revolving stirring devices, there are but few devices in practical operation. In the revolving cylinder apparatus and that with stirrers, the heat is ordinarily delivered directly from conducting surfaces; and, although air is sometimes used as an accessory, they are not really hot-air driers.

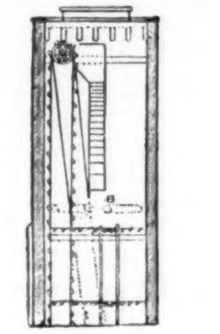
By far the most efficient device for moving material horizontally is the well-known "apron" drier. This consists of a series of superposed, endless aprons, having a slow, continuous motion, each alternate apron moving in opposite directions. Each apron projects slightly at alternate ends beyond its neighbor, and the material under treatment, being fed in a thin layer upon the upper one of a series, is slowly carried forward and deposited successively upon each in turn, and finally delivered at the bottom. The aprons are made of material suitable for the particular substance, and may be perforated; though this, in my opinion, adds little to their efficiency, as the air will always follow the lines of least resistance, which will not be through a layer of the material, however thin. To get a sufficient run, the aprons should have considerable length, and may be of such width as the weight and other properties of the material demand; by which considerations and that of space available, the number of aprons in a drier is controlled. I have recently inspected such an apparatus in practical operation, in use for drying a chemical product, which cannot be subjected to a high temperature. The aprons are eleven in number, spaced 16 in. apart vertically, and are each 50 ft. long and 6 ft. wide, giving a total length of 550 ft. They move at a speed of 150 ft. per hour, the substance being retained in the drier nearly four hours. They are made of cotton cloth, inclosed in a tight wooden casing, and supplied with air, moved by a fan blower over steam coils. The air enters at about 195°, and is discharged at about 135°. Its humidity at discharge is not measured, but from these figures, even making no allowance for losses by radiation, etc., its saturation cannot exceed about 0·18. Obviously this is not an economical application of heat, but as the material contains but little water, this may be of minor importance. The apparatus is considered a fairly satisfactory one, but there is no doubt that by the introduction of the recirculating system, both its economy and efficiency would be promoted.

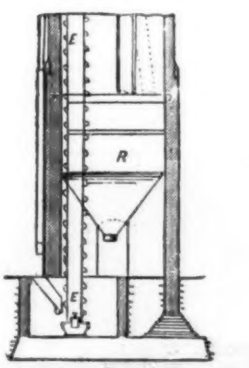
Another drier of this kind is also in use in Brooklyn, N. Y., for drying brewers' grains. This material carries, fresh from the mash tub, from 75 to 80 per cent. of water. As the saturating liquor carries in solution a large amount of valuable food constituents, it cannot be pressed without sacrifice. It constitutes, when dry, a food of high economical and commercial value for cows and horses; the experiments of the New Jersey Agricultural Experiment Station show that for the latter its value is fully equal to that of the best oats, pound for pound. As a food for cows it is largely used wet; but, as it is subject to rapid fermentation and decomposition, in which condition the milk produced from it is exceedingly undesirable as a food, most of the States have stringent laws against feeding cattle with it in that condition; and, in consequence, much of it produced in summer, especially in the larger cities, is given or even thrown away to get rid of it.

It is obvious that with so large an amount of water to eliminate, and the comparatively low value of the dried grains, utmost economy in drying is imperative. The apparatus in question is on a large scale, having a capacity of about 150 bushels of wet grains per hour, which should produce something more than 2,000 lb. dry; this would require the evaporation per twenty-four hours of over 17,000 gals. (United States of America) of water. It consists of ten aprons, each 12 ft. wide by 50 ft. long, spaced about 24 in. apart, and contained in a substantial brick structure nearly 30 ft. high. The aprons are of wire cloth, varying from the uppermost to the lowest apron of the series, from 8 to 14 meshes to the inch. The motion is at the rate of 6 to 8 ft. per minute, giving from 75 to 90 minutes for the transit of the material, which is automatically fed in a very thin layer upon the uppermost apron. The gases, liberally tempered with air in the combustion chamber, are admitted to the drier at temperatures which, perhaps, vary at the different openings of communications, but was said not to exceed 300°, above which point grains are likely to be scorched. The discharge temperature varies under different conditions of the grains as to moisture, and of the atmosphere, but was said to average 160° to 170°; this indicates a low degree of saturation.

But in any attempt to move material horizontally, for drying, unavoidable drawbacks are encountered. Among the most serious of these are: First, the difficulty of controlling horizontal currents of hot air in a chamber of considerable dimensions, which is much increased by the presence of obstructions, moving or stationary. It is found that the current will be principally confined to the upper part of the chamber, and any material near the bottom will be but little affected. This difficulty increases with the height and length of the chamber, and can only be partially remedied by especially locating the positions of the inlet and discharge openings, or by admitting air of different temperatures at different heights in the chamber. Second, the influence of the wind, which, when in an adverse direction, has a tendency to drive the current back, causes great irregularity in the drying, and occasionally almost entirely checks it. Third, the amount of power required to keep in horizontal motion a considerable weight of apparatus and material; and, lastly, and by no means the least important where land is valuable, the large space required for driers of this class.

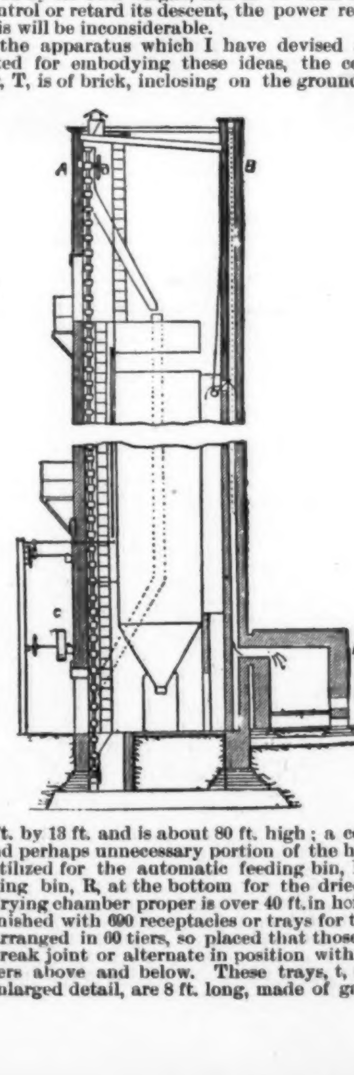
In a vertical chamber or flue the tendency of an ascending current is to diffuse itself uniformly throughout its section; and the presence of obstructions favors and promotes this; also, if the chamber is of considerable height, the natural draught of a heated column will materially assist its ascent, and the direction of the wind will have little or no effect upon it.





The desideratum, then, for handling granular material successfully is a device by which it shall be caused to descend through such a chamber, by a regulated, methodical descent, at such a rate as shall suffice for its drying, and it must be divided into small portions, and frequently turned over, to allow of access of the drying current to all its particles. The material will descend by its own weight, and as we shall only have to control or retard its descent, the power required to do this will be inconsiderable.

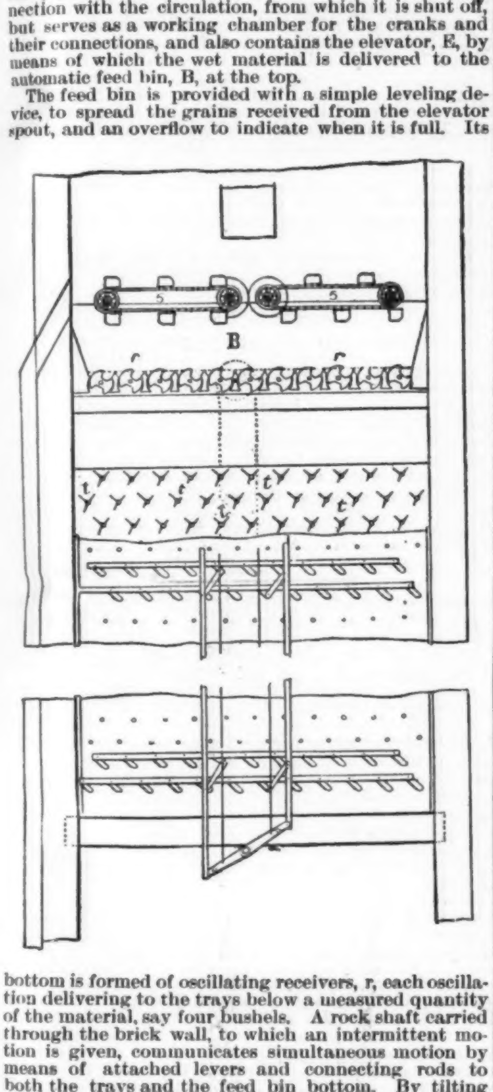
In the apparatus which I have devised and constructed for embodying these ideas, the containing tower, T, is of brick, inclosing on the ground a space of 10 ft. by 13 ft. and is about 80 ft. high; a considerable and perhaps unnecessary portion of the height being utilized for the automatic feeding bin, B, and a receiving bin, R, at the bottom for the dried grains. The drying chamber proper is over 40 ft. in height, and is furnished with 690 receptacles or trays for the material, arranged in 60 tiers, so placed that those in each tier break joint or alternate in position with those in the tiers above and below. These trays, t, shown in the enlarged detail, are 8 ft. long, made of galvanized



* A paper read before the Chemical Society, London, May 6, 1895.—From the Journal of the Society.

sheet iron, having three wings or blades 3½ in. wide, radiating from a common center. These blades form three troughs, of which two have an angle of 105°, these being the working troughs to be alternately filled with the material, the third trough being dormant. For some materials, a cruciform tray is convenient, and for corrosive materials or those liable to discoloration, a wooden construction can be substituted. The trays or receptacles are provided with axles and cranks, and the crank pins being united by rods into a common system, as shown in the larger detail, the whole may be simultaneously oscillated and the contents "dumped." Alternate oscillations in opposite directions will present in turn each of the working troughs of all the trays to receive the falling material, at the same time discharging the contents of the other troughs into the troughs of the tier below; thus at each oscillation causing the entire contents on the drier to descend one step or stage, where it is allowed to remain at rest, awaiting the next oscillation or dumping. The journals of the trays are carried in bearings in a structure of thin cast iron plates, which is spaced at opposite ends some 2 ft. from the brick wall of the tower; this space adjoining the furnaces, with which it is in communication by means of openings controlled by valves, and forms the channel of flue for the return circulation. It also communicates with a receiving chamber, below the trays, by means of a large (90 in.) fan blower, which maintains the circulation. A similar space at the opposite end has no function in connection with the circulation, from which it is shut off, but serves as a working chamber for the cranks and their connections, and also contains the elevator, E, by means of which the wet material is delivered to the automatic feed bin, B, at the top.

The feed bin is provided with a simple leveling device, to spread the grains received from the elevator spout, and an overflow to indicate when it is full. Its



bottom is formed of oscillating receivers, r, each oscillation delivering to the trays below a measured quantity of the material, say four bushels. A rock shaft carried through the brick wall, to which an intermittent motion is given, communicates simultaneous motion by means of attached levers and connecting rods to both the trays and the feed bin bottom. By tilting the trays as described alternately in opposite directions, the material descends step by step from the feed bin to the bottom of the drier, arriving after such interval as may be necessary at the bottom, thoroughly dried. The intervals between the oscillations may be varied from time to time to suit different conditions of the substance under treatment.

The capacity of a drier depends upon the length of time the material remains under treatment and this in turn upon the amount of water to be eliminated, but almost as much upon the facility with which a material will part with its moisture. Thus, if you place upon your desk pieces of clay and of soap, of equal weight, and equally charged with moisture, in a few days' time the clay will have become so dry that you may crumble it with your fingers and blow it away. In as many months the soap will still retain much of its moisture. It is therefore impossible to closely estimate the capacity of a drier for any material on the basis only of the moisture contained. In drying brewers' grains, containing 75 per cent. of moisture, I find that three hours is ample, allowing for oscillations at intervals of three minutes. This gives, at 20 dumps of four bushels each per hour, 80 bushels; or for a pair of driers working 24 hours, 3,840 bushels; the labor required for two driers, two men, being no more than for one. It should be borne in mind that this is for unpressed grains, containing 75 per cent. of water. It is quite practicable, by the use of bag presses, to reduce the water to 50 per cent. or even less, and the capacity of a drier would be increased threefold, and that of a pair of towers of the dimensions described would be say 11,500 bushels per 24 hours of wet grains. The space required for such a pair of driers would be about 50 by 45 ft.

As the solids carried off in the expressed liquor far exceed in value, not merely the cost of recovering them, but of the entire drying, in addition to which is the cost of the pressing, it is obviously uneconomical to press grains before drying them; this is only done because the apparatus employed heretofore fails to dry them without pressing. The grains from the mashtub will seldom contain more than 25 per cent. of solids; the expressed liquor may be safely averaged at 7 per cent., though under not very heavy pressure this will be exceeded. Assuming these figures, and that out of 100 lb. wet grains 50 lb. of liquor is pressed, the dry solids in the liquor will be 3½ lb., i. e., 14 per cent. of the original. At moderate estimate for dry grains of \$16 per ton, 14 per cent. would be \$2.24, which is more by 50 per cent. than the entire cost of drying.

The apparatus said to be in most general use in Great Britain and on the continent of Europe for drying brewers' grains and also to some extent in America and which I therefore take for purposes of comparison, as an approved representative of this class of driers, consists substantially of a steam-jacketed cylinder, within which is a revolving steam drum, carrying stirrers, for agitating the material. It differs from the driers of the same class in details of construction, principally in having a device by which the grains are pressed, and a portion of the liquor expelled, before they enter the cylinder; thus obviating the necessity of separately performing this operation. I am not informed what amount of fluid is thus disposed of; it probably varies considerably. I have been told that, with grains fresh from the mashtub, it is as much as 50 lb. to 100 lb. of grains; which would leave the residue containing still about 57 per cent. of water. The capacity of each cylinder is stated to be 12½ bushels of wet grains per hour, but in another statement 2 lb. dry grains per minute, which is about 25 per cent. less. A plant has lately been erected in New York to accommodate 40 of these driers, with the necessary appurtenances of boilers, engines, etc. This covers a plot of ground 100 ft. by 200 ft. which is said to have cost, including preparation of the site, over \$100 000. When fully occupied and continuously working it will dry per day about 12,000 bushels of wet grains, which is only 500 bushels more than the capacity for pressed grains of the pair of driers described above, occupying 50 ft. by 45 ft. The necessary presses would require little, if any, increased space, as they could be conveniently placed on a higher level. The labor, exclusive of handling the dried grains, is stated to be two engineers, two firemen and two feeders, as against one engineer and one fireman with my apparatus, both for night and day turns.

The expenditure of fuel is stated to be 40 lb. coal to produce 100 lb. dry grains. Assuming that the grains as they enter the cylinder after pressing contain 60 per cent. of water, which is perhaps in excess of the fact, the amount of water to be evaporated per 100 lb. of dry grains would be 150 lb.; hence the evaporation is only 3¾ lb. of water per lb. coal. In the uses of the gases of combustion direct, the loss in the air of discharge being limited by my system of recirculation, it is well within limits to claim an evaporation even in excess of that in a steam boiler, say from 8 to 10 lb. per lb. fuel, when using anthracite or coke as fuel. Experience on a large scale in the horizontal drier described shows that the use of the gases of either anthracite or gas house coke imparts no odor whatever to the grains, but has a slight bleaching effect.

DISCUSSION.

Mr. Henry G. Watel said that the paper opened so wide a field of discussion that it was difficult to deal with it in the short time at disposal. The first point of importance was the temperature at which the air to be used was discharged from the heater. He had made a number of experiments, the result of which was to prove that using a 36 in. fan for blowing in, or a similar fan for exhausting, with a consumption of 12 lb. of gas coke per hour, one could add 100° F. to every 1.000 cubic ft. of air per minute up to the necessary temperature, as proved by experiments ranging over eight days. He had further made experiments on the evaporative power of the hot air thus produced, and found that with air coming from the heater at 250° F. and striking upon a cotton screen kept moistened by throwing water upon it from a pump, it was difficult to keep the screen wet; at the same time the air after passing through the screen was at 140° F. This led to the consideration of the dampness of this air when discharged into the surrounding atmosphere.

He had not statistics on that point with him, but they would be found in an admirable set of hygrometrical tables prepared by Mr. Ferrel, chief of the U. S. A. Signal Service. Assuming that the air entered the heater at a normal temperature, and left it at 240° F., one could readily imagine that it would greedily pick up any moisture that it met with. In the above case with a 36 in. fan, one could hardly keep the screen wet. Different substances, however, required different methods of drying; for instance, photographic plates would not bear drying in air at a high temperature, and he had had to devise special means for dealing with them. On the other hand, starchy matters could not as a rule be successfully treated by cool air. Everything pointed therefore to the importance of the temperature of the discharge.

Mr. Hutchinson had spoken chiefly of experiments dealing with the drying of brewers' grains. This substance was particularly easy to treat by dry air, and was therefore rather outside the question. Members were probably aware that Mr. Fouché had also for many years advocated a system of drying by hot air, using vertical pipes for heating the air. He had demonstrated that vertical pipes had a much better radiant power for heating air than horizontal pipes, and the speed of the air current was also most important. To sum up: the important points to be borne in mind were the temperature at which the air was admitted, the loss of heat which it sustained in the drying chamber, its speed therein, and the temperature at which it made its exit. If the latter were superior to that of the outside air (the heating having been performed in a vertical apparatus), the efficiency and results would be as near perfection as could be obtained.

The chairman drew attention to the great difference between the results obtained by the author of the present paper and those of Mr. Watel, communicated to the society in the year before last. The author claimed at best an evaporation of 8 to 10 lb. of water from brewers' grains per lb. of fuel, which would agree with the usual results obtained from a boiler. Mr. Watel had however claimed an evaporation under favorable circumstances of as much as 220 times the weight of fuel, and although he (the speaker) had pointed out the discrepancy between this and the best results obtained from a multiple effect apparatus, it had been insisted on that the figures given were correct. Then the author spoke of using the same air over and over again.

Mr. Hutchinson dissented, and said that there was a special method of dealing with the air different from the Sturtevant system.

The chairman, continuing, said that, granting this, there still remained a certain amount of moist air which was sent through the apparatus over and over again. If it were desirable to lower the temperature of the heated air entering the apparatus, it would be better to do this by admitting a certain amount of fresh and comparatively dry air instead of heating up the air that had already been charged with moisture by passing through the apparatus. He had applied the hot air system experimentally to the drying of sugar cane diffusion chips, and had found that the only heat which could be economically used was that resulting from waste flue gases. But in the case he had in view, the amount of work to be got out of them was so small, and the power needed for driving the fans was so enormous, that there was little or no advantage in making use of the hot air method. The author of the paper had stated that the product of drying brewers' grains was "equal to the best oats." He presumed that assertion was based upon its analysis, and of course it could similarly be shown that sawdust was adapted for cattle food. As a matter of fact, however, it was obvious that grains which had been stewed at boiling temperature for several hours, and from which the brewer had extracted all he could, were not likely to contain much nutritive material.

Mr. C. C. Hutchinson, in reply, said it was a misconception to suppose the same air was used over and over again for the purpose of evaporation; that, of course, would be attempting the solution of the problem in an impossible and absurd way. Certain portions of the air were circulated through the apparatus over again, but on each circulation a fresh volume of unsaturated air was added and there was a large accession of heat. This fresh quantity of air at a high temperature increased the temperature of the recirculated volume, and its hygroscopic capacity, so that when the mixture was passed up the apparatus and out of the top a volume of cooled saturated air equivalent to the volume of hot air admitted escaped, and carried with it the large quantity of water evaporated. The function of the old air was much the same as that of an intermediate receiver between the cylinders of a compound engine, namely, to keep the temperature during a particular cycle as even as possible, to prevent great variations between the two ends of the apparatus, and to minimize the losses the author had clearly pointed out would be due to using a large volume of fresh air.—Journal of the Society of Chemical Industry.

DUAL ACTION OF THE BRAIN.*

By SAMUEL B. LYON, M.D. Bloomingdale Asylum, White Plains, N. Y.

WHETHER the brain is an organ one half of which is inactive, taking no part in the production of ideas, emotions, and purposive actions, or whether it is a duplex machine, its halves working ordinarily in harmony and for a common purpose, is a most interesting question, and one which is hardly yet definitely settled. Most of us accept the dicta that only the left hemisphere does much thinking, the other being passive and receptive, and perhaps doing occasional vicarious work when the left half has become incapacitated. The participation of both halves of the brain in other than receptive and reflex phenomena has, however, been claimed as a fact by some authors, and certain peculiarities occasionally noted in insane persons give color to the belief that, to a limited extent, both halves may work together as a rule, and on the other hand may get out of harmony with each other, in exceptional cases, as in mental derangements.

Among the insane there sometimes occur cases in which the two sides of the character appear to be so diametrically opposed that it is hard to believe that it is the same individual who appears so differently at different times. There occur alternate states of amiability and intentional personal violence, the latter not being due to persecutory delusions. Delicacy and refinement alternate with most filthy actions and most obscene language. The possession of one of these moods appears incompatible with the actions in the other. We might almost believe that a devilish spirit, if not a personal devil, had entered for the time into a struggle for the possession of a naturally estimable soul. Antagonistic sides in the character, but shown to a less marked degree, are not very uncommon. The ugliness and violence, after a fit, of some ordinarily amiable epileptics; the suspicion and occasional violence in the morning, alternating with placidity and friendliness in the latter part of the day, which occur in some of the reasoning insane, with sexual and other hallucinations, seem like the working at cross purposes of two forces, rather than the disordered actions of one only.

Dr. Lewis C. Bruce, in the spring number of Brain, reports a case of dual brain action. His patient exemplified double consciousness; while in one state he was out of the other, and in one state had no remembrance of his other life. With one state he was right handed, with the other left handed. In one he spoke English, in the other imperfect Welsh. In one, his most nearly natural condition, his pulse was strong and full; in the other, weak, with low arterial tension. The conclusion of Dr. Bruce is that in his case the cerebral hemispheres were capable of individual mental action, and that the mentally active cerebrum, for the time being, had a preponderating influence over the control of the motor functions, the patient living two separate existences during the two stages through which he passed; the mental impressions received during each of these separate existences being recorded in one cerebral hemisphere only.

"If this is not so," he says, "how can one account

* Read before the American Neurological Association, June, 1895.—From the N. Y. Medical Journal.

for the patient's ignorance of events which have happened to him in the Welsh stage when he passes into the English condition? Or his suspicion and distrust of attendants and doctors, ignorance of familiar and much coveted objects, as money and tobacco, when in the Welsh stage; whereas in the English stage he recognizes and is very friendly with the staff, while the sight of money or tobacco is sufficient to bring him running the length of the ward.

"A comparison of the mental power of either cerebral hemisphere places the right at a much lower level than the left. Is this due to the unequal ravages of disease or to the unequal development of education?

"Judging this case by its own characteristic symptoms, one inclines to the belief that even in health each cerebrum must have acted independently and received external impressions separately; that on the advent of mental disease each cerebral hemisphere still maintained its individuality, the left exhibiting symptoms of mania, the right those of melancholia, and that the disease has advanced more rapidly in the right brain, which now exhibits symptoms of dementia."

The possibility of an independent action of the two sides of the brain is not a new supposition. Professor M. J. Luys had a most interesting series of articles on this subject in L'Encéphale in 1888, in which he makes the following statements:

"A great number of transitory and fugitive psychopathic conditions have no other internal mechanism than a disordered action of the two cerebral lobes, each acting singly in its own sphere of activity, and affording thus the explanation of those cases of lucidity, coincident with delirium, and of those cases in which the affected are compelled to do wrong, and at the same time are conscious of their deviation from their normal condition."

One is able to understand what profound perturbation may be thrown into the harmony of the cerebral function by certain morbid stimulations which act on one cerebral lobe while the other remains unaffected. The individual thus affected finds himself divided into two distinct individualities.

Supposing that the lobe which remains healthy continues its normal life, he is conscious of his situation, torn by the opposing forces which are struggling within him and of the influence which is compelling him to do that which he does not wish to do. It is on account of this internal disaccord that these patients, out of equilibrium, so to speak, act in the manner that they do, like one with tetanus, who realizes that his members are successively convulsed, but who is not able to resist their terrible grasp.

These curious manifestations of mental life, which, considered intrinsically, indicate a profound trouble already present in the equilibration of the functions of the brain, have till now been unperceived by the greater number of observers for want of indications sufficiently precise to demonstrate their existence. And if we insist to-day on their existence and their symptomatological value, it is to show that they constitute fixed symptoms—manifestations sui generis, which it is fair to infer have a basis in physical phenomena.

It is not the first time that the theory of a division of the mental activity into two parts has been advanced in psychopathic speculations. It has already presented itself in the minds of certain authors, who, however, considering it a doubtful point, and not being able to make it harmonize with the normal cerebral activity as generally accepted, have contented themselves by advancing an hypothesis, more than a scientific theory which harmonizes with the regular phenomena of cerebral physiology.

Thus, in 1864, Dr. Follet, of the Asylum of St. Athanasia, near Quimper, arrived at the conclusion, from his numerous microscopic researches, that at least among the epileptics there was an inequality of weight between the two cerebral hemispheres, and he formulated ideas on the subject of the evolution of insanity in insisting on the rupture of the equilibrium of the nervous currents in the cerebral mechanism.*

Jaffa also directed his researches in this direction, and has reported a very curious case of a patient who felt himself to be double, and at whose autopsy there was found a decided inequality of the two hemispheres.

This is the résumé of Jaffa's case: "A man, fifty-three years of age, a soldier, abandoned to the abuse of alcohol, having received many blows upon his head, became gradually insane. In speaking, he used the pronoun 'we:' 'We go,' 'We have walked much.' He said that he spoke thus because there was some one with him. At the table he said, 'I am seated, but the other is not.' He would run, and when asked why he did so would reply that he would prefer to rest quiet, but that the other one forced him to run, although he held him back by his clothes. One day he attempted to strangle a child, saying it was not he who did it but the other. Finally he attempted suicide in order to kill the other one, etc. Dementia succeeded in due course.

"The autopsy revealed a considerable difference between the two halves of the brain; the atrophy was principally on the left side. It is evident that the unilateral seat of the lesions had been, if not the only, at least the essential cause of his delirium of a double personality; the individual was different on each side and felt himself to be two persons."

Let us see now upon what proof this theory of the division of the cerebral activity may be reasonably placed in the study of psychopathics.

We have to begin with a curious anatomical fact to notice: 1. The normal deviation in weight between the lobes of the brain, which at most reaches five or six grammes, sometimes seven, to the advantage of the left lobe, is reversed in the brains of the insane. It is the right lobe which has become the heavier, and has absorbed in itself the vigor and nutritive activity of the brain.

This simple fact indicates at the outset a defect in distribution of the nervous matter, a reversal of the normal conditions, and consequently a defect of equilibrium between the dynamic power which each lobe is capable of exerting.

"Upon an abstract of twenty-eight cases of the brains of insane persons which I (Professor Luys) have myself observed and weighed as exactly as possible, I have found the difference in weight between the left and right lobe, which is not more in the normal state than five or six grammes, increase, without any destructive lesion, to eighteen, twenty-five, thirty and forty grammes. In a paralytic whose brain I recently examined, the left lobe weighed four hundred and sixty-eight grammes and the right four hundred and ninety-eight—a curious result, and one which shows us in typical fashion how large a part the disturbance of the equilibrium of the general cerebral function has to do with insanity." *

Finally, there is another point not less significant brought out by these researches, which is, that while in the normal state it is the left lobe which weighs the more, according to the proportions which we have indicated, in the pathological series in twenty-nine cases, in nineteen cases the preponderance belonged to the right lobe.

These unexpected conclusions, if they are confirmed by further researches, will cause us to believe that in the morbid process of insanity the act of nutrition is guided in an opposite direction to that in a sane man in favor of the right hemisphere. It is this which takes to itself the nutritive juices, which augments its mass, which develops in an isolated manner, and becomes thus the instrument of madness.

Among a series of reasoning lunatics, and among expansive hypochondriacs also lucid, this unilateral lesion has presented itself many times in a most significant manner.

We may say then that there exist patent, undeniable facts from which we can construct a typical class of troubles of the mental faculties characterized by systematized delusions coexisting with lucidity, in which we can establish at the same time the unequal participation of the mental apparatus, one cerebral lobe being locally hypertrophied and the other in a normal condition.

If there are cases sufficiently clear in which one may, to a certain extent, see and touch with the finger the lesions which play an active role in the loss of equilibrium of the faculties, there exist on the other hand series of clinical facts in which we are not permitted to go so far, and in which interpretation can only be made by simple induction; a legitimate induction, it is true, from demonstrated facts, but still an induction, seeing it is not capable of demonstration.

How, indeed, shall we explain otherwise than by a loss of equilibrium of the brain, and deviation being principally in one cerebral lobe, the conceptions of certain patients, who explain their sensations and give a sincere account of their physical troubles with which they suffer? They do not voluntarily invent the special vocabulary with which they explain their feelings.†

Having referred at considerable length to the opinion of Professor Luys and Dr. Follet, quoted by him, and the case of Dr. Bruce, recently published, I will submit a case from the records of Bloomingdale, in which the possibility of a dual action of the brain seems to be borne out by her strongly contrasting conduct and language, which were not separate states of consciousness, but opposing conditions present at the same moment.

"Miss —— was admitted to Bloomingdale Asylum, December 7, 1888, in her third attack of insanity. Her age was twenty-three years. Her first attack had occurred four years earlier (age nineteen years), lasting three months; the second attack two years previous, lasting three months; and the third attack, for which she was brought to Bloomingdale, had lasted four months when she was admitted. Her menses have been suppressed for six months, and her present attack began by her acting queerly, taking to her bed, talking incoherently, and becoming increasingly noisy and excited. She had had an aunt and two cousins insane and two aunts consumptive. She was naturally of a modest disposition, with a good intellect and more than average education. Her case pursued a course of increasing violence and excitement, at the height of which her actions were most violent, destructive, filthy, abusive, and insulting to those about her. It is recorded in her history, however, that she has no delusions, and very little intellectual disturbance. The first entry in her case records that she was admitted in an excited state, singing, striking and biting. Her feet were confined to some extent by mechanical appliances. The next day she attacked several of her fellow patients, as well as her attendants, meantime singing and seeming to be in the best of spirits. At the same time she acknowledges that she is very bad, but again she glories in being so, and says the best thing she has done since she came here was to bite a patient. It requires five attendants to dress and undress her. She never loses an opportunity to bite or strike. At the same time she talks rationally about the past, says she would be delighted to play lawn tennis, etc. One entry says: 'Was visited by her father and sister, and talked very nicely to them. Showed that she knew about the recent nomination in Chicago. When they left she spit at them and has been disorderly since.' Said to-day that she regretted being so bad, but could not help it. Would not talk freely in English, but appeared to be delighted to speak in German. Promises to make a great effort to restrain herself. Has bitten, pinched and kicked her attendant until the latter is marked all over her body. She is aware of everything that transpires about her, is a very close observer, and her memory is excellent. Told her father that she considered herself a most difficult patient to get along with. Spoke highly of the kindness of the attendants, and begged her father to bring presents for all of her friends here. During the time she was speaking in this rational manner she was held by two attendants, whom she endeavored to bite and kick at short intervals. She seems ashamed of her actions, but persists in her efforts to injure, and is unable to resist her malicious impulses. Says she cannot help it. Remembers everything that transpires, and converses not only rationally, but in a very entertaining manner."

These notes convey some idea of the condition of this patient, who was naturally of an extremely amiable, gentle, refined, and almost religious character, but during her attack of insanity had an irresistible impulse to do everything contrary to her ordinary nature; and with this impulse, which she exercised freely, she was apparently filled with regret and shame that she was doing such things. While in the very act of trying to bite and kick and spit upon people she would express the greatest regret, and apologize with apparent sincerity for her actions.

The case is interesting for two considerations: first, because of the dual action of mind; and second, because an ovariotomy, performed in January, 1893, has, up to the present time, entirely removed all her insane manifestations, while for nine years preceding the operation she had attacks as often as five times, her periods of insanity becoming longer and her lucid intervals shorter.

If it were possible for two minds to inhabit one body, one of which was by natural disposition, education, and habit refined and gentle in all its tendencies, and the other absolutely lacking in all these qualities, and heartless and cruel to a degree, this patient seemed to possess these two distinct individualities at the same moment. I have frequently witnessed the conflict going on between these two sides of her character, and while she was, in her actions, as ugly and disagreeable as one could possibly be, her language and the expression of her countenance belonged to the refined side of her nature, and were most attractive and interesting.

The facts of double consciousness, of the changed disposition of the epileptic after her fits, and of the opposing impulses in such cases of insanity as I have quoted, are hard to explain on any theory. It is not, perhaps, a greater strain on our credulity to believe that two halves of an instrument, ordinarily acting in harmony, may sometimes get out of equilibrium, than it is to believe that an instrument normally acting in certain lines suddenly changes its nature and product.

Without expressing an opinion, I submit the case, hoping for further light on a very interesting question of the modus operandi of the mind.

* Annales médico-psychologiques, 1864-1866.

* Follet has shown, as we have said, principally among the epileptics, the inequality of the weight of the cerebral lobes; he has found differences as great as fifteen to two hundred and fifty grammes. The same researches have been verified and confirmed by his successor, Dr. Baume, in the same asylum, who has shown that among epileptics an average difference of weight may reach forty grammes. (Baume, Annales médico-psychologiques, 1862, p. 427.)

† Etude sur le doublement des operations cerebrales. M. J. Luys, L'Encephale, 1888.

TRUE AND FALSE PERSPECTIVE.

Our German contemporary, Das Atelier des Photographen, under the able editorship of Dr. Adolf Miethe, and which is always brimful of practical advice and suggestions for the photographic portrait artist, in the current number devotes several pages to true and false perspective, showing the relative effect of the position of the camera upon the portrait of the sitter. This is illustrated by a simple experiment made with a ball or sphere and a piece of chalk or crayon. Four strokes of equal size are made upon the one side, representing the eyes, nose and mouth of the human face.

We have here four illustrations, the first three, 2, 3,

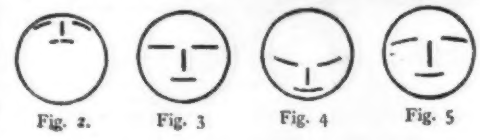


Fig. 2. Fig. 3 Fig. 4 Fig. 5

4, taken from the same standpoint. No. 3 is an illustration where the height of the camera was normal or directly upon a line with the subject, in No. 4 the camera was too high, No. 2 shows the result of having the camera at too low a plane.

No. 5 serves to illustrate cases where the camera is placed too near the sitter or a too short focus lens is used. The height of camera was the same in Nos. 3 and 5.

A study of the four illustrations shows how comparatively easy it is to give a portrait a false or altered expression. Thus where No. 3 shows the mouth small and eyes contracted, No. 5, on the contrary, shows an extended mouth, with eyes angular and separate.

As a matter of course these conditions are even still more aggravated in the human model, where in place of the plane surface here presented, we have to contend with protrusions like the nose and ears, and cavities like the mouth and eyes.

The relative position of the camera is not only of importance in taking head or bust portraits, but becomes of even greater importance where a full-length portrait is attempted; when the camera is set too high the figure appears shorter than the original, and vice versa, when set too low the portrait is apt to appear of an abnormal height.

Thus it will be seen that in many cases the so-called distortion or false perspective in a photograph is less the fault of the focal length of the objective than of its improper application, or the result of carelessness or ignorance of the operator.—Amer. Jour. of Photography.

THOMAS HENRY HUXLEY.

We regret to announce that, after an illness extending back to last March, and relieved only by two or three brief periods of improving health, Professor Huxley passed peacefully into the silence of death on Saturday afternoon, June 29, 1895.

Huxley was born at Ealing in 1825. His scientific training began in the medical school attached to Charing Cross Hospital, which he entered in 1842. Four years later he joined the medical service of the Royal Navy, and proceeded to Haslar Hospital; from there he was selected to occupy the post of assistant surgeon to H. M. S. Rattlesnake, then about to proceed on a surveying voyage in the Southern Seas. The ship sailed from England in the winter of 1846, and returned to England in 1850, after surveying the inner route between the Barrier Reef and the east coast of Australia and New Guinea. During this period, Huxley sent home several papers, some of which were published in the Philosophical Transactions of the Royal Society. His first important paper, "On the Anatomy and Affinities of the Medusæ," was published in 1849. His communications, and the evidence of ability which

they furnished, led to his election into the Royal Society in 1851.

In 1854, Huxley succeeded his friend Edward Forbes as Palæontologist and Lecturer on Natural History at the Royal School of Mines, a post which he held until his retirement in 1885. He was a great teacher, and the high reputation of the school, now combined with the Royal College of Science, is largely due to his great influence. At the request of the lords of the committee of council on education, he continued to act as Honorary Dean of the school, and at death he still retained that post. He also agreed to be responsible for the general direction of the biological instruction in the school, so that his place as professor of biology has never been filled up.

Huxley was twice chosen Fullerian Professor of Physiology to the Royal Institution, the first time in 1854. In the same year he was appointed Examiner in Physiology and Comparative Anatomy to the University of London. Other posts and honors were crowded upon him. In 1858 he delivered the Croonian Lecture of the Royal Society, when he chose for his subject the "Theory of the Vertebrate Skull." From 1863 to 1869 he held the post of Hunterian Professor at the Royal College of Surgeons. In 1862 he was president of the Biological Section at the Cambridge meeting of the British Association, and eight years later held the presidency of the association at the Liverpool meeting. In 1869 and 1870 he was president of the Geological and Ethnological Societies, and in 1872 was elected Lord Rector of Aberdeen University for three years. As might be expected, Professor Huxley held strong and well defined views on the subject of education. He was a man who at all times had a keen sense of public duty, and it was this which induced him to seek election on the first London School Board in 1870. Ill health compelled him to retire from that post in 1872, but during his period of service as chairman of the education committee he did much to mould the scheme of education adopted in the board schools.

He was elected secretary of the Royal Society in 1873, and ten years later was called to the highest honorary position which an English scientific man can fill, the presidency of that society. During the absence of the late Professor Sir Wyville Thomson with the Challenger Expedition, Huxley, in 1875 and 1876, took his place as Professor of Natural History in the University of Edinburgh. From 1881 to 1885 he acted as inspector of salmon fisheries. But this and all his other official posts he resigned in 1885, shortly after which he removed to Eastbourne.

In 1892, more than six years after his retirement, the dignity of privy councilor was conferred upon him. The Copley medal of the Royal Society was awarded to him in 1888, the Royal Medal having been received by him in 1852; and in December last he received the Darwin Medal, the two previous recipients being Dr. A. R. Wallace and Sir Joseph Hooker. His honorary degrees were: D.C.L. (Oxford); LL.D. (Cambridge, Edinburgh, and Dublin); M.D. (Wurzburg); Ph.D. (Breslau). The King of Sweden created him knight of the polar star, and he was elected into most foreign societies and academies of science of note. He was a correspondent of the Paris Academie des Sciences (section of anatomy and zoology), and corresponding member of the St. Petersburg Academie Imperiale des Sciences, the Akademie der Wissenschaften, of Berlin, and of Munich, the Svenska Vetenskaps Akademie, Stockholm, the Halle Akademie der Naturforscher, the academies of natural sciences of Philadelphia, Boston and Buffalo, the Gottingen Gesellschaft der Wissenschaften, the Paris Societe d'Anthropologie, and the Naturforschende Gesellschaft at Frankfurt-a-M. He was honorary member of the Royal Irish Academy, the Accademia dei Lincei at Rome, the Brussels Academie de Medecine, the Institut Egyptien at Alexandria, the Batavia Genootschap van Kunsten en Wetenschappen, the American Academy of Arts and Sciences, National Academy of Sciences and the Amsterdam Akademie van Wetenschappen. He was also foreign member of the Brussels Academie des Sciences, the Haarlem Maatschappij der Wetenschappen, the Philadelphia Academy of Natural Science and the Societa Italiana delle Scienze.

How far-seeing Huxley was, with regard to our present scientific needs, may be gathered from his address when he retired from the presidency of the Royal Society. He saw that scientific literature would have to be organized before it could be fully utilized. His words were:

"We are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science. . . . It looks as if the scientific, like other revolutions, meant to devour its own children; as if the growth of science tended to overwhelm its votaries; as if the man of science of the future were condemned to diminish into a narrower and narrower specialist as time goes on. . . . It appears to me that the only defense against this tendency to the degeneration of scientific workers lies in the organization and extension of scientific education, in such a manner as to secure breadth of culture without superficiality; and on the other hand, depth and precision of knowledge without narrowness."

Another point touched upon in the same address was the claims of science to a place in all systems of education. "We have a right," he said, "to claim that science shall be put upon the same footing as any other great subject of instruction, that it shall have an equal share in the schools, an equal share in the recognized qualification for degrees, and in university honors and rewards. It must be recognized that science, as intellectual discipline, is at least as important as literature, and that the scientific student must no longer be handicapped by a linguistic (I will not call it literary) burden, the equivalent of which is not imposed upon his classical compeer."

To the expression of such views as these we owe the increased attention now given to scientific instruction in this country, though we have not yet reached the impartial stage to which science has a right.

It may, perhaps, be too early to fix Huxley's real place in biology. Writing in these columns in 1874, the eminent German naturalist Haeckel ranked him among the first zoologists in England, taking zoology in its widest and fullest signification.

"When we consider," he remarked, "the long series of distinguished memoirs with which, during the last quarter of a century, Prof. Huxley has enriched zoological literature, we find that in each of the larger divisions of the animal kingdom we are indebted to him for important discoveries."

From the lowest animals he gradually extended his investigation to the highest. In the Protozoa, he was the first to come to satisfactory conclusions concerning the nature of Thalassicollidæ and Sphærozoida; and by his work on "Oceanic Hydrozoa," he greatly extended the knowledge of Zoophytes. His researches upon members of the important group of tunicata are of great value, and many important advances in the morphology of the Mollusca and Arthropoda are due to him.

Further, Huxley especially studied and advanced the knowledge of the comparative anatomy and classification of the vertebrata. His "Lectures on the Elements of Comparative Anatomy," and his numerous monographs on living and extinct species, afford abundant evidence of what biological science owes to him.

Huxley's place as one who has largely influenced modern thought on many questions is acknowledged by all to be a very high one. The profound and truly philosophical conceptions which guided him in his inquiries always enabled him to distinguish the essential from the unessential. First among the subjects which owe their advancement to his support is the theory of biological evolution. When, in 1860, it became his duty as professor at the Royal School of Mines to give a course of lectures to workingmen in the Jermyn Street Museum of Practical Geology, he selected for his subject "The Relation of Man to the Lower Animals." The questions arising out of this topic became the subject of warm controversy at the meeting of the British Association in that and subsequent years. The lectures were published in 1863, under the title "Evidence as to Man's Place in Nature," and excited great interest both in this country and abroad.

In this and in other works he advanced the principles of the Darwinian theory, and worked out many important developments.

To again quote Haeckel: "Not only has the evolution theory received from Prof. Huxley a complete demonstration of its immense importance, not only has it been largely advanced by his valuable comparative researches, but its spread among the general public has been largely due to his well known popular writings. In these he has accomplished the difficult task of rendering more fully and clearly intelligible to an educated public of very various ranks the highest problems of philosophic biology. From the lowest to the highest organisms, he has elucidated the connecting law of development. In these several ways he has rendered science a service which must ever rank as one of the highest of his many and great scientific merits."

As a writer of English, Huxley has been unsurpassed in our time and generation. He has set a standard in scientific literature, both in clearness of exposition and in the most perfect handling of words, which it behoves his successors to closely follow. He aimed at writing clearly, and avoided the use of technical language whenever possible.

As he remarks in the preface to the volume of "Collected Essays" containing his biological and geological addresses: "I have not been one of those fortunate persons who are able to regard a popular lecture as a mere, hors d'œuvre, unworthy of being ranked among the serious efforts of a philosopher, and who keep their fame as scientific hierophants unsullied by attempts—at least, of the successful sort—to be understood of the people. On the contrary, I found that the task of putting the truths learned in the field, the laboratory and the museum, into language which without bating a jot of scientific accuracy shall be generally intelligible, taxed such scientific and literary abilities as I possessed to the uttermost; indeed, my experience has furnished me with no better corrective of the tendency to scholastic pedantry which besets all those who are absorbed in pursuits remote from the common ways of men, and become habituated to think and speak in the technical dialect of their own little world, as if there were no other."

This journal especially loses in him one of its best friends. We are now in the second series of fifty volumes, and his was the hand that commenced both of them. His introduction to the fifty-first volume will be fresh in the minds of our readers, and it justified the position he had occupied since 1859, as the devoted apostle of the Darwinian theory. He was, moreover, not only a most valued contributor to our columns, but his advice on many points has been freely asked, given, and followed, during a quarter of a century.

Huxley's wonderful kindness to young men is very well known. He would discuss subjects with his students, and his perfect geniality put them entirely at their ease. Always ready to extend a helping hand, he assisted many to higher ranges than they could otherwise have attained, and by words of encouragement induced others to continue their ascent.

The objects which Huxley stated he had in mind from the commencement of his scientific career are these:

"To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength that there is no alleviation for the sufferings of mankind except veracity of thought and of action and the resolute facing of the world as it is when the garment of make believe by which pious hands have hidden its uglier features is stripped off. It is with this intent that I have subordinated any reasonable, or unreasonable, ambition for scientific fame, which I may have permitted myself to entertain, to other ends; to the popularization of science, to the development and organization of scientific education; to the endless series of battles and skirmishes over evolution, and to untiring opposition to that ecclesiastical spirit, that clericalism, which in England, as everywhere else, and to whatever denomination it may belong, is the deadly enemy of science. In striving for the attainment of these objects, I have been but one among many, and I shall be well content to be remembered, or even not remembered, as such."

How nobly he acted up to his principles we all know, how greatly the pursuit of his objects have benefited intellectual and material progress, we can only estimate.

In the preface of the fifth volume of his "Collected Essays," Huxley gives a quotation from Strauss' "Der alte und der neue Glaube," which describes so exactly the guiding principles of his life that it is difficult to believe the lines were written by another hand nearly a quarter of a century ago. "For close upon forty years," wrote Strauss, "I have been writing with one purpose, from time to time I have fought for that which seemed to me the truth, perhaps still more, against that which I have thought error; and in this way I have reached, indeed overstepped, the threshold of old age. There every earnest man has to listen to the voice within: 'Give an account of thy stewardship, for thou mayst be no longer steward.' That I have been an unjust steward, my conscience does not bear witness. At times blundering, at times negligent Heaven knows, but on the whole, I have done that which I felt able and called upon to do; and I have done it without looking to the right or to the left; seeking no man's favor, fearing no man's disfavor."

Huxley leaves a wife and seven children—three sons and four daughters. They mourn the loss of a loving husband and father, and their affliction is shared by all who were fortunate enough to know him as a friend. But his loss will not only be felt by these; it affects the whole intellectual world. Men will arise who, like him, will advance and extend scientific knowledge by research and exposition, but rarely will the qualities of the investigator and interpreter be combined with a more charming personality.—Nature.

[Knowledge.]

SCORPIONS AND THEIR ANTIQUITY.

By R. Lydekker, B.A.Cantab., F.R.S.

To the circumstance that scorpions have their bodies protected by a coat of the hard substance technically known as chitine, the palæontologist is indebted for a knowledge of their past history and extreme antiquity; and it is owing to the preservation of their remains in the Palæozoic strata of both the old and new worlds that we are enabled to explain their present geographical distribution. There are many other groups of Invertebrates that we can have little doubt are fully as ancient as scorpions, but which lack a hard external investment, and whose past history is accordingly a blank. One of the most remarkable instances of this is afforded by the peculiar creatures termed Peripatus, representatives of which are found in countries as remote from one another as South Africa, New Zealand, Australia, South and Central America, the West Indies, and Sumatra. These animals have much the appearance of caterpillars, having a pair of simple antennæ, and a large number of short, conical, caterpillar-like feet extending along the whole length of the under surface of the body, and each terminating in a pair of hooked claws. They breathe by tracheal tubes, after the manner of insects, but instead of these tubes opening by a regular series of apertures along each side of the body, their openings are scattered in an irregular manner over its whole surface. And it has been considered probable that these animals are closely related to the ancestral stock of insects, spiders and their allies, and myriopods. This being so, it is evident that Peripatus must be an extremely ancient type, and there is a great probability that if their remains were suitable for preservation we should find evidence of their existence in some of the oldest rocks of the northern hemisphere. It has, indeed, been assumed from their present geographical distribution that these, as well as many other types of animals, have always been southern forms, and that their presence in the great southern continents and islands indicates a former union of all the lands of the southern hemisphere. That there was a south equatorial belt of land in Palæozoic times seems to be pretty evident from certain peculiarities connected with the Carboniferous flowers of the northern and southern hemispheres, and it is, therefore, possible that in the case of Peripatus such an explanation may be the true one. Since, however, palæontology teaches us that many ancient types have migrated from their original northern home to find a refuge in the remote parts of the southern continents and islands, it seems more probable that such has also been the case with Peripatus. And if we can show that this has been the case with the scorpions, which now attain their maximum development in the more southern portions of the globe, the argument will be strengthened in the case of Peripatus.

Probably most of my readers are fairly well acquainted with the external appearance of scorpions, but, for those who are not, the publishers have reproduced a very beautiful photograph of a large African species, kindly sent me by Dr. R. M. Howard, of Namaqualand, and locally known as the sand scorpion. Belonging to the great group of Arachnida, which includes the spiders, the scorpions are especially distinguished by their compressed bodies, and by the sharp separation of the cephalo-thorax from the abdomen, the latter consisting of seven segments, and being followed by six narrower segments, collectively forming the post-abdomen, the last of which is specially modified into the so-called sting. The cephalo-thorax or fore part of the body is covered by a shield-like carapace, upon the upper surface of which are carried a variable number of simple eyes, one pair of which is larger than the others, and is placed dorsally, while the smaller ones are marginal. The first pair of appendages are modified into short nipping claws, while the maxillary palpi are greatly enlarged to form the huge pair of pincers carried on each side of the head; and the four pairs of walking legs are supported by the first four segments of the thorax. It is important to add that by means of pulmonary sacks, opening by four pairs of apertures on the sides of the abdomen, scorpions breathe air, and it is accordingly only in rocks of fresh water origin, or such as were deposited near the shore, that their remains are likely to be preserved.

According to the most recent classification, existing scorpions are divided into four families, of which the first two are again subdivided into several families. An important feature in this classification are the so-

called "pedal spurs," which are found upon the articular membrane connecting the foot, a terminal segment of the legs, with the segment that precedes it. According to Mr. R. I. Pocock, the Scorpionidæ, or typical scorpions, have only one such spur, whereas two are present in the other three families. It will, however, be quite unnecessary to further consider the classification of the group in this place; but it is important to notice that one of the sub-families of the Scorpionidæ is confined to Africa south of the Sahara, and the Indian and Malayan countries; while another has representatives not only in those regions, but also in northern South America and Australia. At the present day, indeed, scorpions are found in Europe only in the more southern countries, where the majority of the species are of comparatively small size; and it is in the tropical and sub-tropical regions of the globe that the group attains its maximum development, the largest forms being, we believe, South American and South African. No scorpions are found in high northern latitudes, although they range as far south as Patagonia, and none are known from New Zealand. The species here figured belongs to the typical sub-family of the Scorpionidæ, which is confined to the Ethiopian and Oriental regions.*

According to the researches of Dr. Scudder, the modern scorpions agree with one another in that the median dorsal eye tubercles are, as a rule, far removed from the front margin of the cephalo-thorax, and thus placed behind the lateral eyes. Apparently the only fossil scorpions agreeing with this group that have been hitherto discovered occur preserved in amber of late Tertiary age; scorpions being quite unknown in lower Tertiary or Secondary rocks. Needless to say that this is not owing to their non-existence in these epochs, but is due either to such rocks being unsuited to the preservation of their remains, or having been deposited far out to sea.

When, however, we reach the Palæozoic coal measures, which are mainly of fresh water origin, and, therefore, just where we should expect to find such creatures, remains of scorpions have been met with both in Europe and North America, some of the species attaining very considerable dimensions. Both in these Carboniferous scorpions and also in certain still older ones from the Silurian rocks, the eye tubercles are placed either on the actual front margin of the cephalo-thorax or only a short distance behind it; and these forms are thus regarded as forming a group apart from the modern scorpions. In the Carboniferous genus Cyclophthalmus, the median eye tubercles are immense, and occupy almost the entire front half of the cephalo-thorax; the lateral eyes forming a semicircle behind and to the sides of the larger ones. The maxillary palpi form pincers proportionally as large as in the modern forms, while the legs have similar double claws. The genus Eoscorpius, which is likewise common to the Carboniferous rocks of both halves of the northern hemisphere, has all the general features of the preceding, with the exception that the arrangement of the eyes is different; while Proscorpius, of the upper Silurian rocks of North America, is also of the same general type. With Palæophonus, of the Silurian of Scotland and Gotland, we reach, however, a more primitive type, in which the walking legs gradually taper to thin extremities, which terminate in simple claws or points, although the palpi still form large pincers.

Such is the palæontological history of scorpions; and a very remarkable history it is, seeing that most of the Palæozoic types are almost as highly specialized as their existing descendants, and thus showing that we should have to go much further back before we reached the ancestral type. With the exception of certain cockroach-like insects, which occur in the middle Silurian, the scorpions are indeed the oldest land animals, and are therefore entitled, in spite of their unpleasant propensities, to our utmost respect.

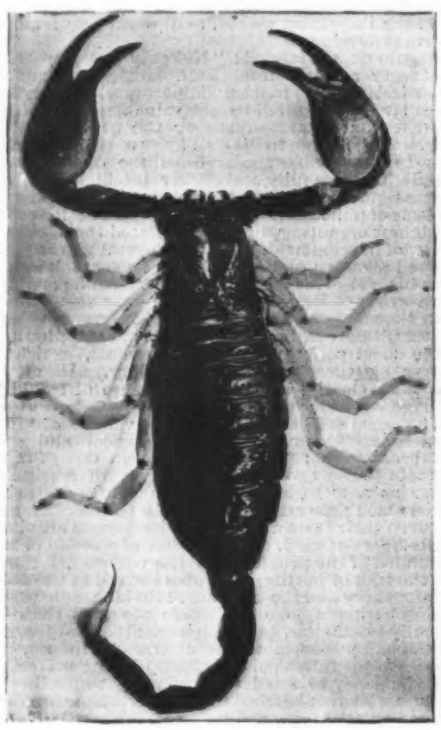
We have said that in Palæozoic times there existed a south equatorial land girdle, distinguished from the land of the northern hemisphere (from which it was probably isolated) by the peculiar character of its fauna; and as the Palæozoic scorpions inhabited the northern land, it is scarcely likely that they were also found in the southern zone. Early in the Secondary epoch the latter zone appears to have been split up, and the continental areas consequently assumed some approach to their present configuration. The descendants of the ancient Palæozoic scorpions began soon after, in all probability, to migrate southward, along the different lines of communication; and we thus can readily understand why some of the existing sub-families are represented in such widely separated areas as India, Africa, South America and Australia, without resorting to any comparatively recent connection between these countries. In this connection it is important to notice that the South American and African scorpions belong to distinct genera.

If such an explanation holds good in the case of the scorpions, there is no reason why it should not be equally valid in the instance of Peripatus. It may be objected that, whereas in the case of the scorpions we have only sub-families which occur over such widely sundered areas, in Peripatus we have one and the same genus. The objection would, however, be equally valid if we assumed that genus to have attained its present geographical distribution by the aid of a southern band of land, seeing that there is no evidence that such a tract has existed since the end of the Palæozoic or the commencement of the Secondary epoch.†

Although not coming strictly within the scope of its title, this article may be concluded by a brief reference to some of the habits of scorpions. All scorpions are nocturnal and somewhat sluggish creatures; but while some species, in which the tail is light, carry it stretched nearly straight out behind, those in which it is heavier habitually curve it over the back; and those forms in which the appendage is carried in the latter manner are further distinguished by raising their bodies much higher on the legs than is the case with the others. Some kinds, again, when walking, carry their large pincers stuck out in front of the head to act as feelers. All scorpions are carnivorous, while many of them, in spite of their sluggish appearance, are able to capture and kill such alert creatures as cockroaches. Mr. Pocock, who has kept scorpions in captivity, writes that "as soon as a cockroach is seized, the use of the scorpion's tail is seen, for this organ is brought rapidly over the latter's back, and the point of the sting thrust into the insect. The poison instilled into the wound thus made, although not causing immediate death, has a paralyzing effect upon the muscles, and quickly deprives the insect of struggling powers, and consequently of all chance of escape. If the insect is a small one—one in fact that can be easily held in the pincers and eaten without trouble while alive—a scorpion does not always waste poison upon it. Thus I have seen a Parabuthus (one of the genera of scorpions) seize a bluebottle fly, transfer it straight to its mandibles, and pick it to pieces with them while still kicking. . . . An insect is literally picked to pieces by the small chelate mandibles, these two jaws being thrust out and retracted alternately, first one and then the other being used; the soft juices and tissues thus exposed being drawn into the minute mouth by the sucking action of the stomach."

Old fables die hard, and none is more persistent than the legend that the scorpion, when surrounded by a ring of fire, puts an end to its existence by turning its tail over its back and stinging itself to death. No matter that naturalists have proved that their poison is innocuous to their own kind, and that scorpions are killed by a very moderate elevation of temperature, the old, old story is still as firmly believed as ever by the general public.

In an article published in the last edition of the Encyclopædia Britannica, the Rev. O. P. Cambridge refused to believe that there was any substratum of fact in the popular legend, but Mr. Pocock, writing in Nature for 1893, is more merciful. He thinks, indeed, that a scorpion may occasionally sting itself, either by



THE GIANT SAND-SCORPION OF NAMAQUALAND.

a random blow meant for an unseen enemy, or when it has been irritated by the contact of any strong stimulant, such as acid or mustard, or even that in the madness of pain it may be driven to turn its weapon on itself; but that in any case there is any intention of causing its own death cannot for a moment be admitted.

Although, probably, many of my readers are acquainted with it, for the benefit of those who are not, I must conclude with a well known Indian story. Where scorpions and centipedes abound, it is the general custom of servants in India to turn their masters' boots upside down before helping to put them on. In the instance in question, where this precaution had been omitted, a cavalry officer had just put his foot into a regulation boot, when he felt something sharp touch his heel; with the greatest promptitude he lifted his leg and stamped violently on the ground in the hope of destroying the supposed scorpion before it had time to use its sting. He found that a spur, with the rowels uppermost, had been inadvertently dropped into the boot!

* Mr. Pocock writes me that he believes the specimen to be Opisthophthalmus pallipes. The total length of the specimen in the original photograph, which is natural size, is just over five inches.

† It may be well to state that there are many fatal objections to the theory of an Antarctic continent, which united South America, Africa, and Australia, having existed in Tertiary times.

THE COLOCYNTH.

Consul Edwin S. Wallace, writing to the State Department from Jerusalem, says: The colocynth or bitter apple (which provides in its dried pulp a well known purgative medicine), grows abundantly on the maritime plain that lies between the mountains of Palestine and the eastern shore of the Mediterranean. It is found from below the city of Gaza on the south to the base of Mount Carmel on the north. The dwellers along this plain pay little attention to the plant, and spend neither time nor labor in its cultivation. It grows without cultivation, the soil and climatic conditions producing it without the help of the husbandman.

The plant itself resembles our common cucumber, but its fruit is globose, about the size of an orange, of a light brown color. Its rind is smooth, thin, and parchment like.

The fellaheen, or peasants, gather the fruit in July and August before it is quite ripe. It is sold to Jaffa dealers, who peel it and dry the pulp in the sun. It is then moulded into irregular small balls, packed in boxes, and shipped mostly to England.

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